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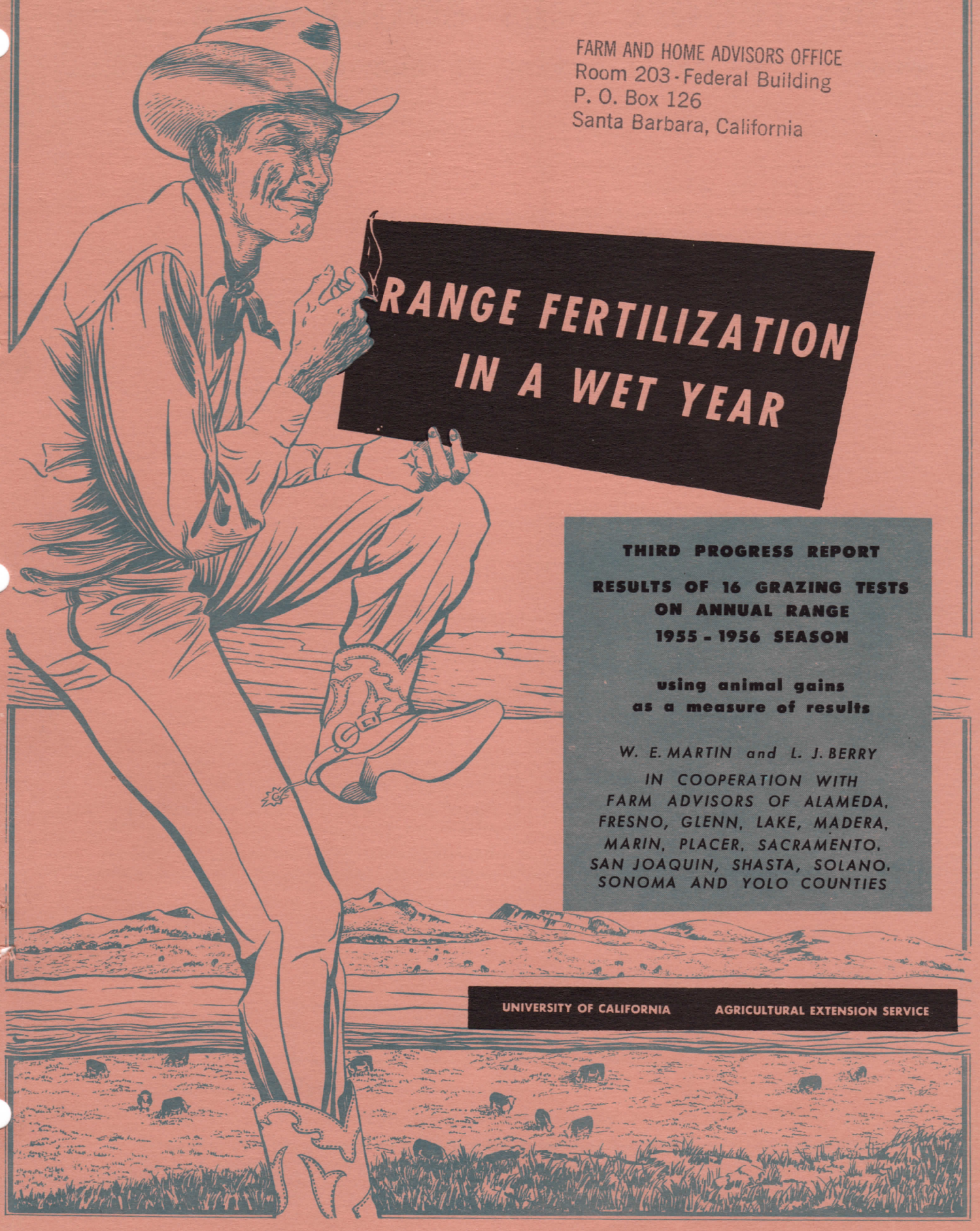


RANGE FERTILIZATION IN A WET YEAR

THIRD PROGRESS REPORT

RESULTS OF 16 GRAZING TESTS ON ANNUAL RANGE 1955 - 1956 SEASON

using animal gains as a measure of results

W. E. MARTIN and L. J. BERRY

IN COOPERATION WITH FARM ADVISORS OF ALAMEDA, FRESNO, GLENN, LAKE, MADERA, MARIN, PLACER, SACRAMENTO, SAN JOAQUIN, SHASTA, SOLANO, SONOMA AND YOLO COUNTIES

UNIVERSITY OF CALIFORNIA AGRICULTURAL EXTENSION SERVICE

This report tells about ★ ★ ★

PROBLEMS OF RANGE FORAGE PRODUCTION • • where fertilizers may help

THE TWO METHODS OF USING FERTILIZERS ON RANGE

• • (1) to pep up clovers with Phosphorus and Sulfur

• • (2) to stimulate grasses directly with Nitrogen

HOW FERTILIZER MAKES GRASS GROW IN THE WINTER

• • when it often stands still and gets frosted

RESULTS OF CLIPPING TESTS ON ANNUAL RANGE WHICH SHOWED

• • how much extra forage we may get from N, NP, and P fertilizers

• • how these fertilizers affect Protein and Phosphorus content of forage

• • how much of fertilizer nutrients are recovered in the forage

THIRD SEASON'S RESULTS OF "U. OF C." FERTILIZER GRAZING TESTS

• • applying Nitrogen and Phosphorus and "NP" materials on annual range and using ANIMALS GAINS to MEASURE RESULTS

These 16 tests in 13 counties on 2543 acres showed in wet winter and dry spring that

CATTLE AND SHEEP GRAZING ON FERTILIZED FIELDS

"needed less acres".....average carrying capacity was more than doubled

"produced more meat per acre"..... meat yields increased an average of 93 pounds per acre

"made enough EXTRA meat at prevailing prices to pay for fertilizer or show a <u>profit</u> in 13 of 16 tests"

RANGE FERTILIZATION IN A WET YEAR

Results of 16 Field Tests Comprising the Third Year's Program on Range Fertilization

W. E. Martin and L. J. Berry

I. INTRODUCTION

Actual meat production by cattle or sheep over a period of years on typical range will decide whether or not range fertilization is economically feasible. Only by this means may we find out whether dollars spent for fertilization have returned value enough to justify the expense.

This report for the 1955-56 season is the third in a series. It presents the results of 16 field-scale cooperative grazing tests carried out by the University of California Agricultural Extension Service on typical range in Northern and Central California. As in previous years, weight gains of commercial animals are used to measure the effectiveness of the fertilizers applied.

The winter of 1955-56 was one of the wettest on record and, while not "typical", must be recognized as one of the conditions under which range fertilization must be evaluated. Seasonal rainfall was 44 percent above normal at stations near sites of the grazing tests. At five locations over 20 inches of rain fell in the late December and early January storms. Flooding conditions prevailed and soils remained water-logged for weeks. Growth of forage was greatly retarded and in some cases "drowned out" by the ponded water. At several locations stocking of experimental fields had to be delayed because of flooded conditions.

Forage at normally drier locations may have benefited from the greater-than-normal total rainfall. In spite of the heavy winter rains spring drought occurred at most locations. Spring forage growth was seriously reduced and saved only by rain near the close of the growing season.

Before discussing the results of these tests, it may be well to outline some of the problems of range forage production and to review some of the fertilizer work already done on California rangeland.

II. THE PROBLEM

California range makes up somewhat over a third of the area of the state. It includes about ten million acres of open treeless range, plus about 25 million acres of oak-grass woodland and brushy areas used primarily for grazing. Much of this rangeland has been grazed by cattle or sheep for at least a century. To date little has been fertilized. Present forage is composed principally of annual grasses, clover, and filaree.

Most of the open range and low-lying portions of the oak-grass woodland are used for the production of green winter feed. At higher elevations and along the coast where rains continue longer, the range provides green spring and early summer feed. Late summer and fall feed is from the dry grasses and legumes produced during the spring months.

Three problems of range forage production may be helped by fertilization:

First, there is usually a shortage of green feed in the early part of the winter grazing season. Annual grasses and legumes grow slowly during the winter months, even though adequate soil moisture is present. The major production of forage comes in a great flush in the spring when soil and air temperatures have increased and soil moisture is still adequate. Feed dries up quickly in late spring as soon as the rains cease. This uneven seasonal growth makes for a feast or famine situation. Quickly available nitrogen-plus-phosphorus fertilizers greatly speed up growth of grasses during the cool winter months.

Second, total feed production may be poor because of low soil fertility. Here little forage is produced even when temperature and moisture conditions are favorable. Such soils are often acutely deficient in phosphorus, sulfur, or nitrogen.

Third, forage quality is often poor. Winter and spring-growing annual grasses make good feed while green or approaching maturity. Many of these same species are of low nutritive quality and some are unpalatable and even injurious when mature and dry. Fertilizer treatments that increase the growth of legumes and desirable annual grasses, along with proper livestock management, will improve the quality of dry feed for summer and fall use.

Unpalatable summer weeds such as star thistle and tar weed reduce quality of dry feed for summer use. They grow where annual grasses and legumes lack the vigor to fully extract available soil moisture. Fertiliztion of desirable species can stimulate vigorous growth and greatly reduce the summer weeds.

III. TWO APPROACHES TO RANGE FERTILIZATION

First, stimulate native and introduced legumes by fertilization with phosphorus, sulfur or other materials.

Second, direct fertilization of grasses with nitrogenous fertilizers containing phosphorus, and sulfur where needed.

Previous Work on Range Improvement Through Legume Fertilization:

The aim of legume fertilization has been, first, to improve current feed supplies and second, to help build up soil fertility. A large number of range tests have been set up throughout the state by the Agricultural Extension Service, in cooperation with staff workers of the Department of Agronomy. These tests included phosphorus, sulfur, potassium, lime, and other materials. At many locations, phosphorus or sulfur-bearing fertilizers, alone or in combination, greatly increased growth of native or introduced clovers.

Sulfur fertilization of annual grasses and native clovers has increased average carrying capacity approximately 50 percent in grazing studies continued over a seven-year period at the San Joaquin Experimental Range in Madera County.

Phosphorus fertilization of annual clover seedings on commercial ranches near Lincoln has resulted in a threefold increase in grazing capacity. These tests carried out by the staff of the University of California Agronomy Department demonstrate that rose, crimson, and sub-clover were better able to use phosphate fertilizer than were native resident species. As a result more feed of higher protein and phosphorus content were produced.

In tests such as these, effective range improvement was achieved at low cost. The amount of spring forage was increased. The quality of feed, both green and dry, was improved by the greater proportion of high protein legume vegetation. A residue of organic nitrogen was left in the soil, which stimulated grass growth the following season.

Legume fertilization, though very effective in increasing both spring and summer feed and forage quality, has serious limitations. First, it does not provide the early feed needed on many winter ranges. Second, in many areas, soils are well enough supplied with phosphorus and sulfur so that added fertilizers cause no growth increases. Third, some seasons, known as poor clover years, have temperature and rainfall conditions such that poor legume growth is made regardless of fertilizer applications.

Previous Work on Range Improvement Through Nitrogen Fertilization of Grasses:

The aim in using nitrogen fertilizers has been to fertilize the grasses directly and thus increase forage production. Nitrogen treatments were included in many of the range fertilizer tests carried out by the Agricultural Extension Service and Department of Agronomy. In nearly every test, the grasses present responded to nitrogen. In a few cases, clovers responded.

In this series of exploratory tests, several patterns of nitrogen response on grasses appeared. On soils well supplied with phosphorus, nitrogen treatment alone made as good early and total growth as did nitrogen-phosphorus combinations. On soils acutely deficient in phosphorus, little benefit at any season was obtained unless phosphorus was used with the nitrogen applied. Many soils showed a seasonal or winter deficiency in phosphorus. On these soils, nitrogen-phosphorus treatments gave large increases in winter and early spring growth. Here straight nitrogen applications showed little result in the winter, but produced good grass growth in the spring after soil temperatures had increased. On some sulfur-deficient soils, ammonium sulfate applications made for better grass growth than equal nitrogen from ammonium nitrate.

A series of range fertilizer clipping plots has recently been carried out both by the Soil Conservation Service and by the University of California Agronomy Department. The plots of the Soil Conservation Service Sunol Nursery near Pleasanton, showed for six successive years an average increase of production of 2,879 pounds per acre over the control as a result of annual applications of 200 pounds of 16-20 ammonium phosphate sulfate. At current fertilizer prices, the extra feed was obtained at a cost of $5.64 per ton of dried forage.

Similar plots by the University of California Agronomy Department at the Brown Ranch in Sacramento County on a phosphorus deficient soil showed that over a two-year period 6,775 pounds of extra forage was produced from a single application of 1,600 pounds of 16-20. 82 percent of the gain came during the first season. The total gain was achieved at a fertilizer cost of $7.25 per ton. More recently, at the University of California Hopland Range in Mendocino County, fertilizer strips were laid out on seeded legume-perennial grass pasture, where there is little winter growth, although rainfall is adequate. In the winter of 1953-54, feed production to March 30 was increased from 540 pounds per acre on the control to 3,944 pounds with 400 pounds of ammonium sulfate, and to 6,349 pounds with 519 pounds of 16-20. Here, the out-of-season winter feed was produced at a fertilizer cost of $6.60 to $7.40 per ton.

Five field-scale grazing tests were carried out by the Agricultural Extension Service and cooperating ranchers in 1953-54.

Ten field-scale grazing tests were carried out in the 1954-55 season as a continuation of the first group. Meat production by grazing animals was used to evaluate the results of fertilizers applied.

In every case earlier winter feed was produced on the nitrogen-fertilized fields. In addition of phosphorus and sulfur increased growth only on soils deficient in these nutrients.

Frost damage was clearly less on the fertilized areas.

Animal carrying capacity was more than doubled.

Average meat production was increased from 72 up to 197 pounds per acre.

The average increase of 125 pounds meat per acre was produced for a fertilizer cost of 12.4 cents per pound.

IV. RELATION OF CLIMATE AND FERTILITY TO WINTER FORAGE PRODUCTION

The most striking and consistent results in the entire series of range fertilizer plots and demonstrations have been the fact that supplemental nitrogen fertilizers stimulate early and continued winter and early spring growth of annual grasses. These responses have occurred during the cold season when little growth would normally be expected. Nitrogen appears to be the key to early growth, but was effective only if adequate phosphorus and sulfur were present or were applied in the fertilizers used.

Three factors - moisture, temperature, and nutrient supply govern the growth of range plants. Throughout California, rainfall usually comes during the winter months when temperatures are at their lowest. The bulk of the feed production does not come until the spring when soil temperatures have increased and moisture is still adequate. The warming up of the soil as spring approaches permits the liberation of nitrogen from organic reserves and crop residues in the soil. This increases the nutrient supply and causes the range forage to grow in a great flush of spring growth, which slows to a stop as rains cease and the dry summer approaches.

It is ironic that the most favorable growing temperatures occur when there is little rain, and that good moisture conditions occur when soil temperatures are usually too low for natural growth of range plants. Winter temperatures are apparently too low for soil bacterial processes which bring about decomposition and mineralization of organic matter and legume and crop residues. The same winter temperatures, however, are not too low for grass and alfilaria and other forage plants if adequate nutrients are present in available form.

It is possible to provide nitrogen and phosphorus out of the fertilizer sack to make up the deficit induced by cold winter and spring temperatures. By this means grasses can be encouraged to grow in much of our winter range when they do not do so normally.

The relationship of winter temperature, rainfall, and fertility, to winter forage growth may be shown graphically in Figure 1 from the data taken in the Santa Clara County test in 1954. This soil was deficient in both nitrogen and phosphorus Clippings were made at monthly intervals from enclosures in fertilized and control fields. These yields of forage are plotted along with the corresponding temperature and rainfall records.

It is clear that the yields of unfertilized forage occurred only when temperatures were rising, rainfall decreasing but adequate, and moisture was still present. The yields decreased rapidly as spring rains ceased.

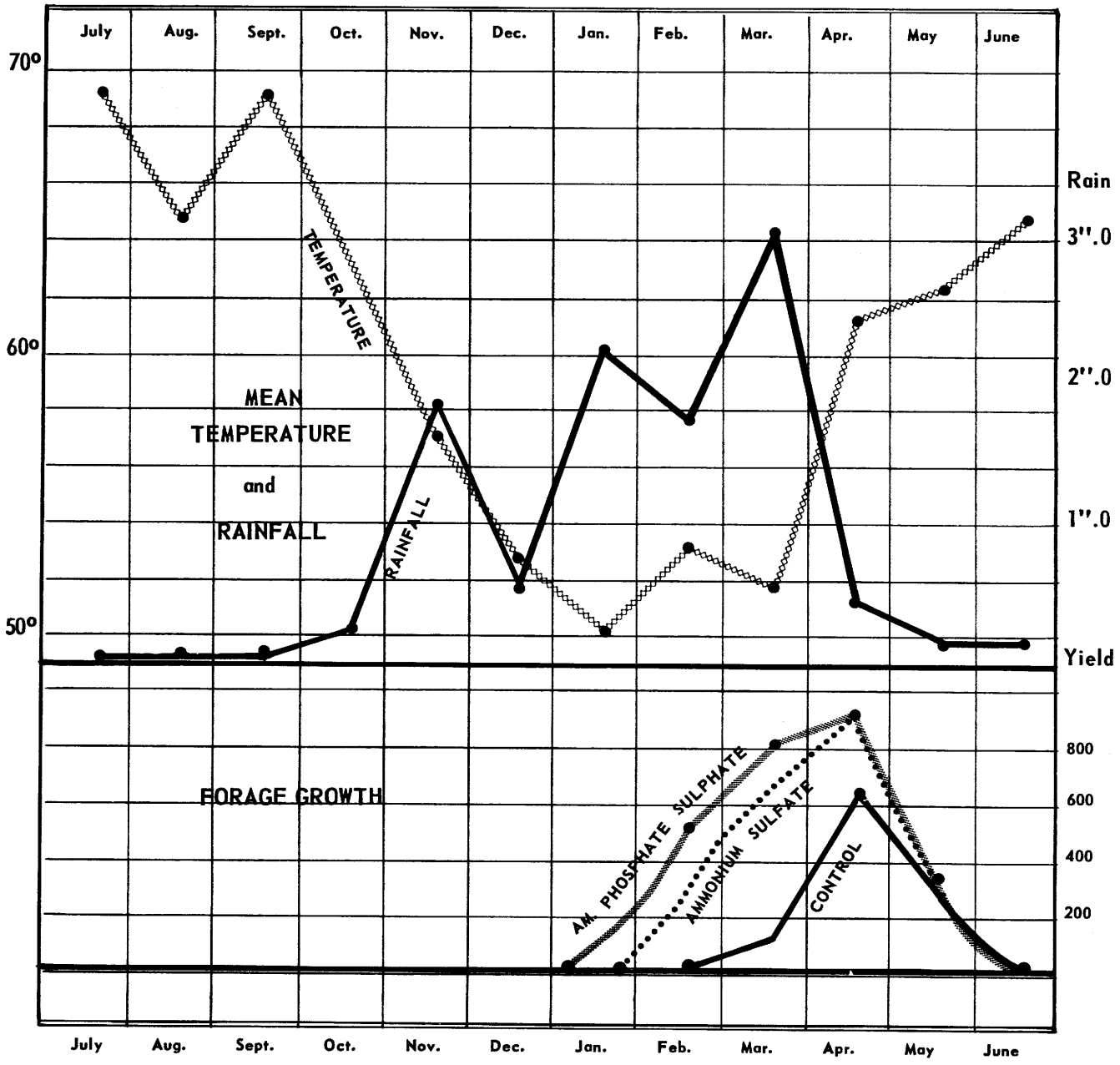
On the ammonium sulfate treated field, growth was hastened, and took place well in advance of that on the control, but not nearly as rapidly as where both nitrogen and phosphorus were applied to this seasonally phosphorus deficient soil.

Both early and total forage production were increased and the grazing season hastened by supplying the nutrients, nitrogen and phosphorus at the time of year when conditions for growth were favorable, but soil-supplied nutrients insufficient.

This chart illustrates a potential we have in much of our range area for making plants grow during the winter, provided normal rainfall occurs during this period. Where excessive rainfall occurs and soils remain water-logged over long periods, growth plants may not be able to utilize the nutrients provided.

SEASONAL GROWTH OF ANNUAL RANGE AS RELATED TO FERTILIZATION, RAINFALL AND TEMPERATURE

Santa Clara County, 1953-54



V. LAYOUT OF RANGE FERTILIZER GRAZING TESTS

Site Selection:

Animal grazing tests on fertilized range were set up in thirteen counties in the fall of 1955. They were set up for the specific purpose of finding out how much nitrogen-phosphorus fertilizer could be used most profitably on winter range. Meat production during the grazing period was used as a measure of success. Tests were in Alameda, Fresno, Glenn, Lake, Marin, Madera, Placer, Sacramento, San Joaquin, Shasta, Solano, Sonoma and Yolo counties. All were field-scale trials carried out on lands selected as typical of extensive areas in each county. Some tests were on good productive range. Others were on poorer range, depleted by years of heavy grazing, or areas of low initial capacity and seeded to improved range species. Some were in areas known to be deficient in phosphorus or sulfur, while others were on soils well supplied with these nutrients.

The size of experimental fields was often large, in order to get a fair cross-section of rangeland and to accommodate sufficient animals to obtain reliable results. Field size was also dictated by the size of suitable fenced fields that might be divided for treatment and also by the location of stock water holes. Fertilized fields were approximately the same size in each test - usually 10 to 60 acres - while control fields were often larger. The total acreage in all sixteen tests was 2543 acres, of which 1316 were fertilized.

Fertilizer Treatments of Experimental Fields:

The basic plan of these tests was to have a control field and one or more adjacent fields fertilized with various nitrogen and nitrogen-phosphate treatments. Nine of the sixteen tests involved multiple treatment. In five counties plots were planned in such a way that all fertilized fields received equal nitrogen with varying amounts of phosphorus. Five tests were set up to compare nitrogen-phosphorus vs. control. Five other tests compared straight nitrogen vs. control. In one test on improved clover range two phosphorus rates and a nitrogen-phosphorus treatment were compared with the untreated area.

Carry-over effects were studied at three locations. In one case carry-over effects of straight nitrogen were measured. In a second the residual effects of ammonium sulfate were measured on a sulfur deficient soil. In the third case the effect of a 1955 application of phosphorus receiving supplemental nitrogen in 1956, was compared with an annual application of both nitrogen and phosphorus.

Airplane application was used in six of the field tests. This means of application is satisfactory in spreading materials on lands too rough for ground equipment.

Costs of application by plane in these tests varied from 60 cents to $1.00 per CWT., or from $1.25 to $2.75 an acre. These costs are higher than by ground rig on accessible terrain and with good equipment. Even on smooth terrain, the airplane offers advantages when time is short and insufficient labor and ground equipment available.

Stocking of Experimental Fields:

Grazing was carried out as close to normal ranch operations as possible. In the cattle tests, young animals, weighing from 400 to 600 pounds, were used. Fertilized fields were stocked at rates estimated as proper for the available feed. Untreated fields were stocked on the same date at rates selected by the rancher as the normal carrying capacity of the range.

All animals were removed and the test terminated by mutual agreement with the rancher when nearly all of the green feed had been utilized, thus leaving enough growth to provide dry feed for normal fall use. Every effort was made to graze the fields so as to utilize the available feed but not to over-graze any of the treatments. The control and the fertilized fields were grazed during the same period.

Measurement of Results:

All animals were weighed when placed in the fields and again when removed. Test weighings were made during the season to determine progress. Stocking rates were changed if the condition of the range indicated it. Results are expressed as (1) total grazing days per acre; (2) average daily gains per animal (3) pounds of meat per acre; and (4) fertilizer cost per pound of extra meat produced per acre.

Clipping Tests in Fenced Exclosures:

Fertilizer plots were set up within fenced exclosures in the control fields of eight of the grazing tests. Varying rates of nitrogen and phosphorus were applied.

The range of rates included those actually used in the treated fields.

Clippings were made to determine:

(1) the amount of early and late feed produced
(2) the percent dry matter in the green forage harvested
(3) the percent phosphorus and crude protein in the dried material
(4) the percent recovery of the fertilizer nutrients applied

These plots also served as visual demonstrations of the forage produced in the treated fields and eaten by grazing animals.

Analysis of samples was made in the Agricultural Extension Service Laboratory in Berkeley and by the University of California Department of Agronomy at Davis.

VI. INFLUENCE OF FERTILIZER ON YIELD AND COMPOSITION OF RANGE FORAGE IN 1956

Effects of N and NP Fertilizers on Yield and Composition of Native Annual Range

Yields of forage as affected by fertilization were measured from clippings of plots set on three high phosphorus and on three phosphorus deficient soils. Results are shown graphically on the opposite page.

On the high phosphorus soils there was no significant effect of phosphorus fertilizers when added alone or with nitrogen. On these same soils the yield of forage was almost directly proportional to the rate of nitrogen applied in both "winter" and "spring" growth periods. The major part of the "extra forage" from nitrogen applied came in the winter period.

On the phosphorus deficient soils, phosphorus fertilizer alone did not increase total forage either in the winter or spring cuttings. Native legumes responded somewhat to added phosphorus but not enough to appreciably affect yields. In the winter period nitrogen was clearly effective only when applied with phosphorus, and responses proportionate to the amount of nitrogen applied. In the spring period nitrogen alone did increase grass growth on these phosphorus deficient soils but to a much lesser degree than where phosphorus was also added.

The reason for the failure of nitrogen-phosphorus combinations to produce as much "winter forage" as on the high phosphorus soils is not known. It is suspected that delayed response on these soils may have been related to waterlogged soils at these locations during the winter "flood" periods.

The cost of the "extra forage" produced by fertilization is shown below. On the high phosphorus soils straight nitrogen treatments made the cheapest feed for a fertilizer cost of $15-$16 per ton. The addition of phosphorus increased cost but not production. On phosphorus deficient soils cheapest feed was produced with NP combination at approximate cost of $18-$19 per ton. On these soils yield increases from nitrogen alone were slight and cost excessive.

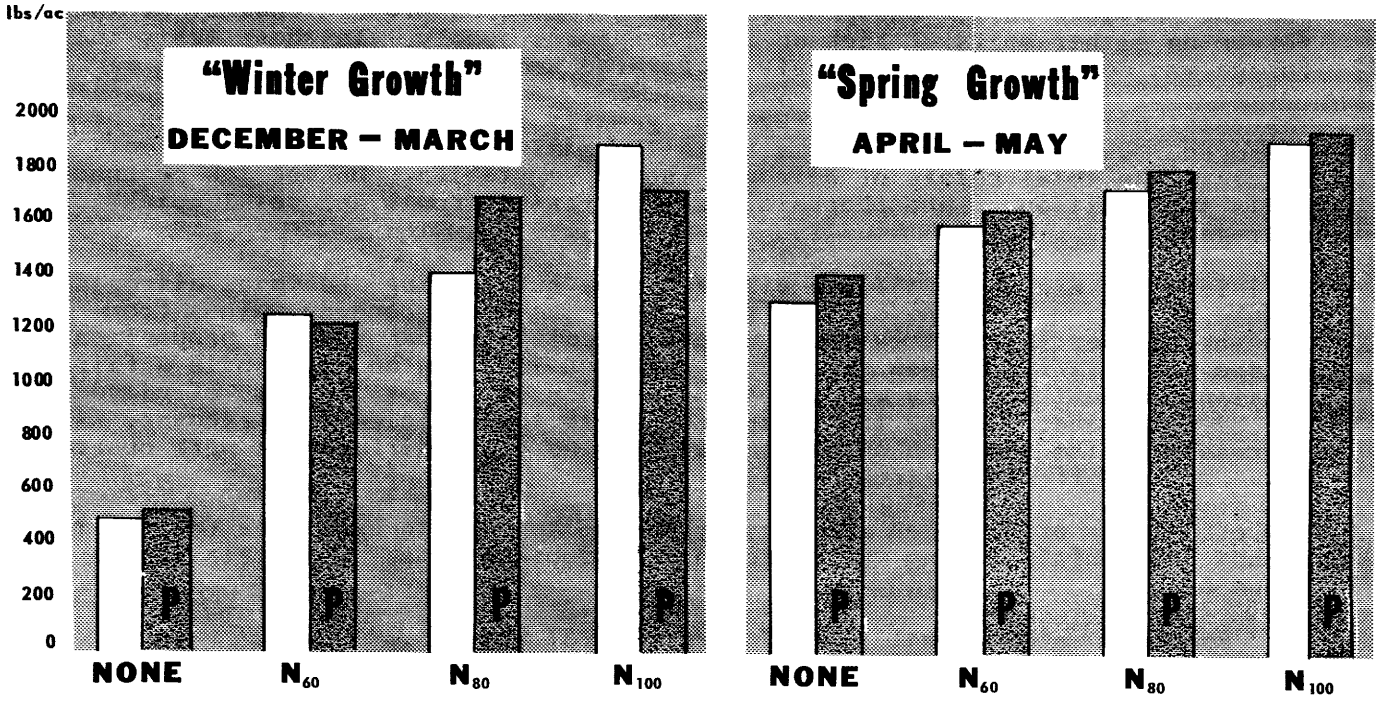
COST OF EXTRA FORAGE FROM RANGE FERTILIZATION

Expressed as $ per Extra Ton of Dried Forage *

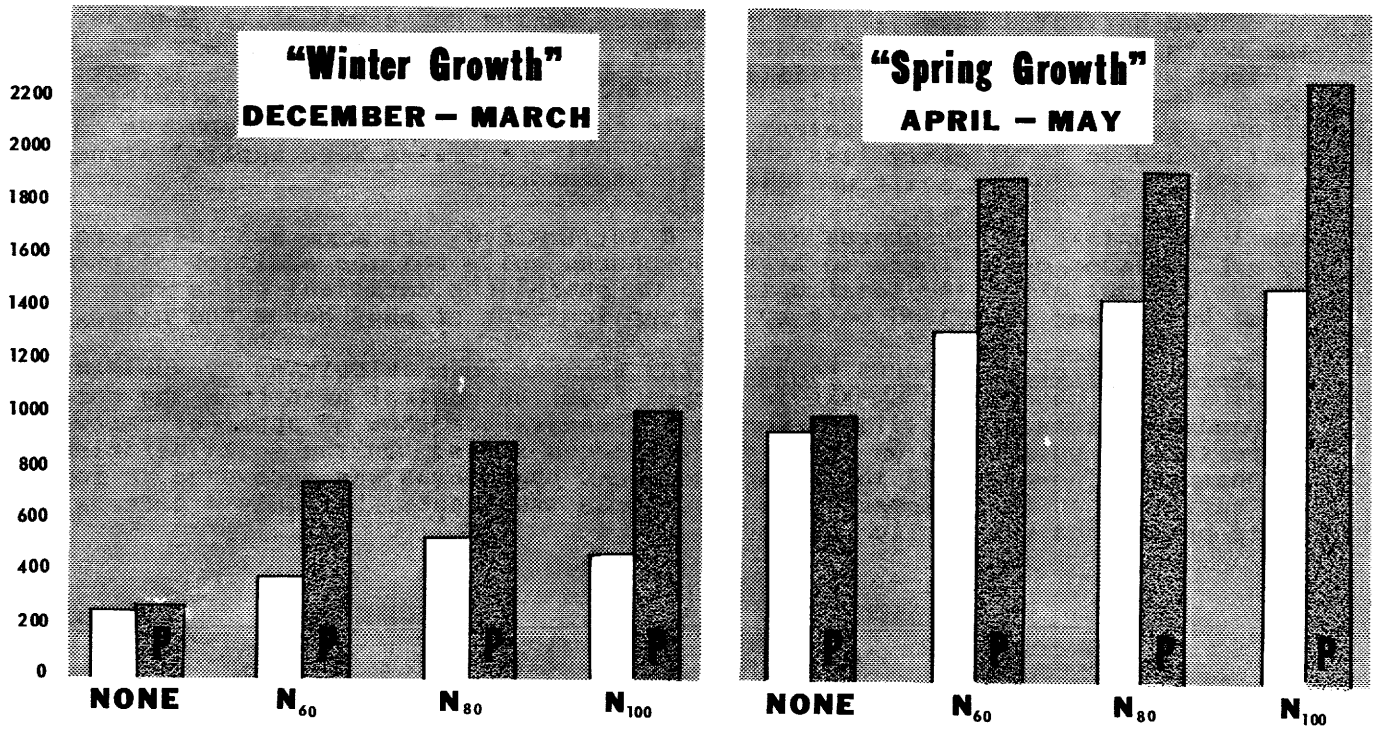
Nitrogen Applied	Soils with High Phosphorus		Soils Deficient in Phosphorus	
Lbs/Acre	No Phosphorus	P_{40}	No Phosphorus	P_{40}
None	--	--	--	--
60	$15.70	$22.14	$34.40	$17.90
80	16.51	17.59	30.53	19.42
100	15.44	21.30	39.36	18.14

* With N @ 15¢/lb. and P (P_2O_5) @ 10¢/lb.

EFFECT OF FALL FERTILIZATION ON YIELDS OF ANNUAL RANGE ON THREE HIGH PHOSPHORUS SOILS



ON THREE PHOSPHORUS DEFICIENT SOILS



Pounds of Nitrogen Applied per Acre

P = 40 lbs P_2O_5/ac

The percent crude protein in forage was only slightly affected by fertilization but was affected far more by degree of maturity of the forage when harvested. In five of the six plots studied the protein content of the winter growth was increased slightly by the application of nitrogen. The protein content of the spring growth in no case was significantly affected by application of nitrogen the previous fall. Phosphorus had no effect upon protein content of the forage on either soils of high or low phosphorus supply. In these tests the forage was composed almost entirly of filaree and annual grasses.

The total nitrogen uptake in forage was greatly increased by application of nitrogen. On the high phosphorus soils the addition of phosphorus did not increase the total uptake of nitrogen in the vegetation. On the low phosphorus soils the addition of phosphorus clearly increased growth and total uptake of nitrogen.

Efficiency of use of fertilizer nitrogen. By subtracting the total nitrogen uptake of forage from the control areas from the corresponding values from the various fertilizer treatments we may calculate the amount and proportion of the fertilizer nitrogen recovered. At each location on high soils a fairly constant percent recovery was observed, whether 60, 80 or 100 lbs. of nitrogen had been applied. On the low phosphorus soils the efficiency of recovery was increased by the addition of phosphorus, but no clear differences were observed between the different nitrogen rates.

The efficiency of nitrogen recovery by forage appears to have been related to amount of rainfall during the phenomenal December storms. This relation is shown below:

Rainfall -	Seasonal	36.1"	28.0"	27.9"	18.2"	23.2" rain
	December	15.5"	13.6"	11.8"	9.0"	8.0" "
Average recovery of Nitrogen applied		29%	33%	40%	39%	53%

The phosphorus content of the forage, expressed as percent total phosphorus of the dried harvested material, was much lower on the deficient soils than on the soils with adequate phosphorus supply. The percent phosphorus was increased by applications of fertilizer phosphorus on the deficient soils but not on the high phosphorus soils. The addition of nitrogen had no significant effect upon the phosphorus content of the forage, although the phosphorus content tended to be slightly less where high nitrogen rates were applied alone or with phosphorus on soils deficient in phosphorus.

The total uptake of phosphorus expressed as pounds P_2O_5 per acre was increased by applications of nitrogen to high phosphorus soils but the addition of phosphorus did not alter the total uptake. On phosphorus deficient soils the total uptake was increased both by the applications of phosphorus and nitrogen.

The efficiency of phosphorus recovery and use has been calculated by subtracting the total phosphorus uptake in forage from the control area from the corresponding values of fertilizer forage. These values show no apparent recovery of fertilizer phosphorus on the high phosphorus soils. On the soils deficient in phosphorus however, 17 to 23% of the added phosphorus was recovered in forage harvested on the nitrogen plus phosphorus treatments, but only 4 percent where phosphorus was applied alone.

EFFECT OF FERTILIZATION ON PROTEIN CONTENT AND N RECOVERY IN RANGE FORAGE

	ON HIGH PHOSPHORUS SOILS				ON PHOSPHORUS DEFICIENT SOILS			
** Fertilizer Treatment	% Crude Protein *in Winter Gr.	Spring Gr.	Total N Uptake lbs/ac.	% N Recov.	% Crude Protein in Winter Gr.	Spring G.	Total N Uptake lbs/ac.	% N Recov.
Check	11.7%	8.0%	27.6		11.0%	6.6%	12.5	
P_{40}	12.3	9.2	34.2		11.6	6.5	14.5	
N_{60}	11.9	9.1	50.8	39%	14.1	7.4	21.5	15%
$N_{60}P_{40}$	12.3	9.7	56.6	38	13.7	6.2	33.0	31
N_{80}	12.4	9.5	58.5	39	14.5	7.8-	25.1	16
N_{80} P_{40}	12.7	8.7	63.9	37	14.0	6.3	38.7	30
N_{100}	13.0	10.1	70.9	43	14.8	7.8	24.5	12
N_{100} P_{40}	12.9	9.8	59.2	25	15.5	6.4	49.0	35

* Expressed as Percent of Dry Weight of Forage Harvested
**Expressed as Pounds N & P (P_2O_5) Applied Per Acre

EFFECT OF FERTILIZATION ON PHOSPHOROUS CONTENT & P_2O_5 RECOVERY IN RANGE FORAGE

	ON HIGH PHOSPHORUS SOILS				ON PHOSPHORUS DEFICIENT SOILS			
Fertilizer Treatment	% Total P* Winter Growth	Spring Growth	Total P_2O_5 Uptake lbs/ac.	Percent Recovery of P_2O_5 applied	% Total P in Winter Growth	Spring Growth	Total P_2O_5 Uptake lbs/ac.	Percent Recov. of P_2O_5 applied
Check	.348%	.290%	13.1		.135%	.150%	3.9	
P_{40}	.317	.286	13.7	1.5%	.195	.194	5.5	4%
N_{60}	.344	.280	21.9		.151	.126	4.7	
$N_{60}P_{40}$	.307	.280	22.1	.5	.245	.178	11.5	17
N_{80}	.335	.272	22.9		.149	.131	5.4	
$N_{80}P_{40}$	.320	.265	24.2	3.3	.229	.175	12.6	18
N_{100}	.345	.268	26.1		.138	.121	4.8	
$N_{100}P_{40}$	.335	.275	23.9	- 5.5	.225	.162	14.1	23

* Expressed as Percent of Dry Weight of Forage Harvested
**Expressed as pounds of N & P (P_2O_5) applied per acre

Effects of Phosphatic Fertilizers on Yield and Composition of Improved Clover Range

On the opposite page are shown results of phosphorus fertilization of an improved clover range on a phosphorus deficient soil. The area had been seeded five years previously to annual clovers. A good stand of rose clover persisted but had made little growth. Rose clover is strikingly responsive to phosphorus applications where soil phosphorus is low.

Yield of forage was sharply increased by fertilizer applications. The resident annual grasses and filaree were not affected, but clover growth increased over 300%.

Cost of extra forage produced was $7 to $9 per ton for the first season on the plots receiving the 57 and 114 pound P_2O_5 applications (300 and 600 single Superphosphate). Substantial carry-over may be expected from the higher treatment rates.

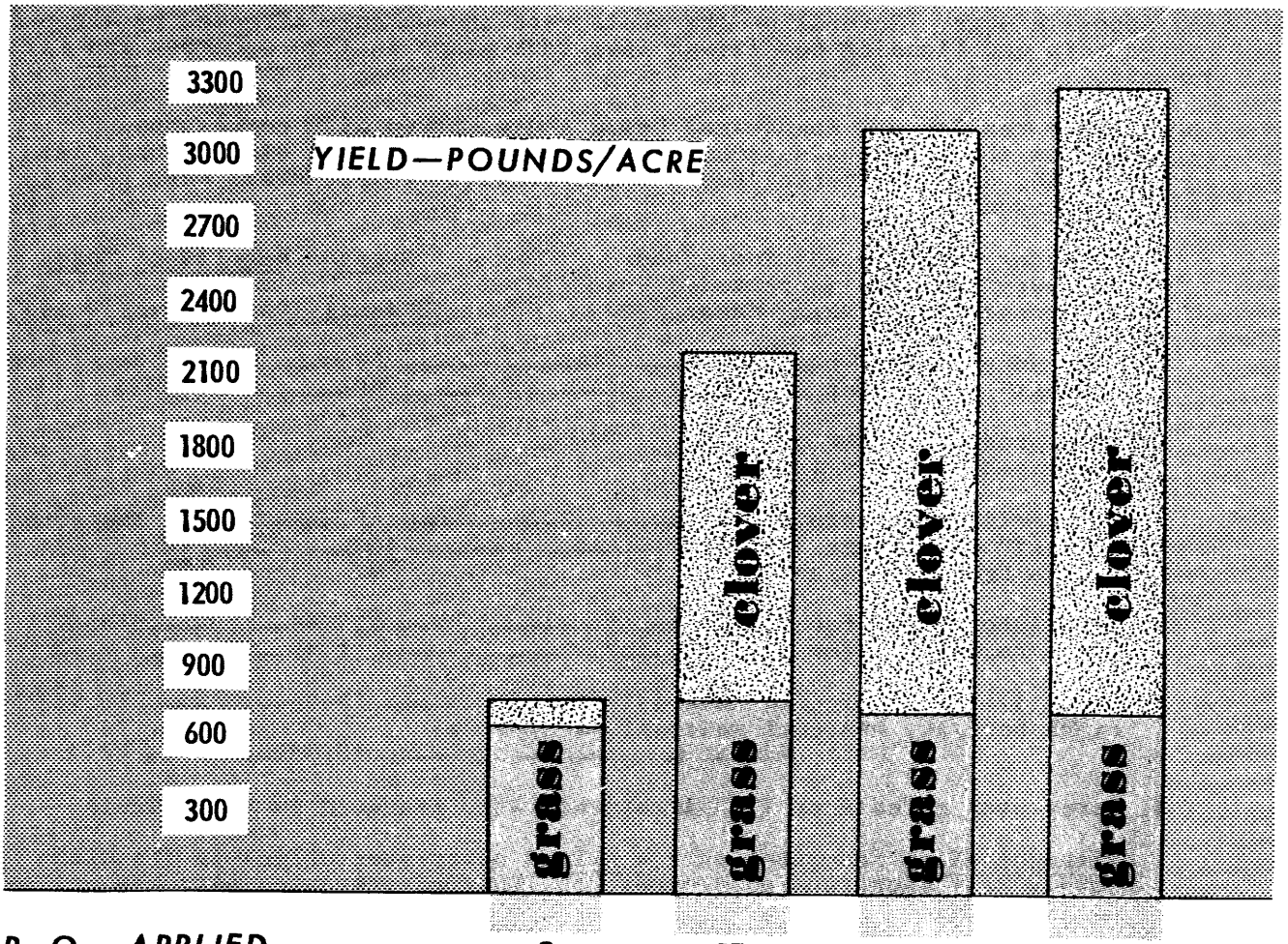
Protein content of whole forage was sharply increased. The Superphosphate increased the protein content of clover itself as well as the proportion of high protein clover in the forage.

Phosphorus content, both of grass and clover, was increased by fertilizer application.

Results above are in sharp contrast with tests on unimproved annual range on similar phosphorus deficient soils. For phosphorus alone to increase yields responsive legumes must be present. In this case they had been planted. In the other tests reported in the preceding section on pages 8 and 10 native or resident legumes were either not present in sufficient amount or not responsive to applied phosphorus fertilizer.

Fertilization of phosphorus deficient range where responsive legumes are present increased spring feed supply and improved the forage quality for spring and particularly summer use. It had the disadvantage of not providing early feed. Grazing on this area was not possible until April, while adjacent range fertilized with nitrogen-phosphorus combinations had ample feed for grazing by early February.

Effect of Superphosphate on P Deficient Rose Clover Range



$P_2 O_5$ APPLIED	0	57	114	228	lbs/ac
COST/ACRE	–	$5.20	$10.40	$20.80	per acre
COST/EXTRA TON OF FORAGE	–	$7.29	$8.83	$16.46	per ton
COMPOSITION OF FORAGE					
% CRUDE PROTEIN	8.4%	12.4%	13.9%	14.4%	
% TOTAL P	.152%	.167%	.207%	.253%	

VII. EFFECT OF FERTILIZERS ON MEAT PRODUCTION ON RANGE

A. Grazing Tests with Cattle in 1956

The results obtained from the thirteen field-scale grazing tests are listed on the opposite page. Several of the tests were undoubtedly affected by the prolonged rain and flooding conditions that took place in late December and early January.

The average results are summarized below and compared with corresponding figures from the previous season. It is recognized that a strict comparison is not valid, since different ranches and fertilizer treatments were used in the 1956 season.

1. Carrying capacity was increased in every test and is recorded as average no. grazing days/acre

	Average Results of Tests		
	13 tests 1956	10 tests 1955	
On unfertilized range	37	40	days/acre
"Best" fertilizer treatment	90	102	

2. Beef production per acre was increased in every test

Unfertilized range	65	72	lbs/acre
"Best" fertilizer treatment	162	197	
Gain from fertilization	97	125	

3. Fertilizer cost per acre was: (for materials $13.44 $13.57; (for applications 1.49 2.12)

4. Fertilizer cost of extra beef/ac. was: (for materials only 13.9¢ 10.9¢/lb; (for materials & application 15.3¢ 12.4)

5. Carry-over effects of 1955 treatments were measured in three tests.

   Nitrogen alone from urea gave a slight carry-over effect in the Glenn County test where spring droughts in 1955 had prevented nitrogen utilization.

   Nitrogen and sulfur from ammonium sulfate gave a striking carry-over effect in Madera County. On this sulfur deficient soil a striking growth of native clovers resulted from the 87 pounds of sulfur applied in ammonium sulfate in 1955.

   Phosphorus carry-over in Sacramento County enabled nitrogen alone to do nearly as well as the 1956 NP treatment on soil where both nitrogen and phosphorus must be used initially for satisfactory results. Similar results were observed in a San Mateo test that was abandoned because of the sale of animals.

6. Superphosphate on improved clover range greatly increased spring forage, which was converted into extra meat at a fertilizer cost of only 7.2¢/lb. The pastures, however, were not ready to graze until April, while a nitrogen-phosphorus treated field which made beef for 16¢/lb. was ready by February 1st.

7. The "fertilizer cost" of extra beef/acre produced on fertilized fields is used to evaluate results. In six of the thirteen tests this fertilizer cost was below 15¢/lb. In three tests costs were 15-18¢, while in four tests in areas of high rainfall or subject to prolonged soil water-logging, the costs were in excess of 24¢/lb.

   Using an arbitrary beef value of 18¢/lb., nine of thirteen tests returned fertilizer costs or showed a profit. For the entire group the average profit with 18¢ beef was $2.60/acre after deducting costs of fertilizer and application.

SUMMARY OF UNIVERSITY OF CALIFORNIA FERTILIZER GRAZING TESTS WITH CATTLE - 1956

County, Rainfall, and Ranch	Fertilizer Treatment	Beef Production: Grazing Days/ Acre	Av. Daily Gain lbs.	Beef from Pasture lbs/ac.	Gain from Fertilizer lbs/ac.	Evaluation of Results: Cost of Fert. Material $	Cost of Fert. Applic. $	Cost/lb of extra meat/ac.
Alameda 12.6"	Check	43	1.92	83				
Mulqueeney	N_{80}	79	1.76	140	57	12.25	1.22	23.6¢
Fresno 18.2"	Check	36	1.66	60				
Sunland	N_{80}	70	1.83	128	68	11.06	1.50	18.0¢
	$N_{80}P_{40}$	87	1.54	134	74	14.66	1.50	21.8
	$N_{80}P_{68}$	94	1.93	182	122	16.61	1.50	14.8¢
Glenn 23.3"	Check	20	1.53	30				
Sevier	$N_{64}P_{20}$	70	1.63	109	79	11.08	1.51	15.8¢
(1955 Carry-over)		29	1.59	44	14			
Madera 13.8"	Check	21	1.49	30				
McKinney	$N_{80}P_{100}$	88	2.16	189	159	22.00	.74	14.3¢
Madera 26.4	Check	15	2.54	37				
Olsen	N_{60}	70	2.03	141	104	8.03	.47	8.2¢
Madera 18.2"	Check	45	1.75	79				
Urrutia	N_{80}	136	1.88	256	177	11.26	.74	6.8¢
(1955 Carry-over)		81	1.86	150	71			
Placer 30.2"	Check	40	2.02	100				
Alrich	P_{49}	58	2.46	173	73	4.77	.50	7.2¢
	P_{108}	73	2.46	179	79	10.49	.75	14.2¢
	$N_{70}P_{49}$	117	1.72	202	102	15.32	1.00	16.0¢
Sacto. 27.9"	Check	34	1.55					
Van Vleck	Supplement	53	1.82	97	44	(3.63)		8.3¢
N_{80}(P	Carry-over)	84	1.72	144	91	10.40	1.45	13.0¢
	$N_{80}P_{40}$	111	1.63	181	128	14.88	2.08	13.3¢
San Joa. 24.8"	Check	27	1.68	50				
Beckley	$N_{80}P_{38}$	86	1.77	169	119	16.24	.80	14.3¢
	$N_{80}P_{80}$	86	1.77	170	120	19.00	.80	16.5¢
Shasta 51.7"	Check	25	2.33	57				
Crowe	$N_{80}P_{50}$	70	1.63	114	57	16.40	2.40	31.3¢
	$N_{80}P_{100}$	52	2.08	108	51	22.10	2.43	44.2¢
Solano 28.0"	Check	106	1.82	192				
Lawler	N_{76}	130	1.74	228	36	9.88	1.82	32.5¢
Sonoma 36.1"	Check	20	1.60	32				
Redwood	$N_{59}P_{33}$	48	1.63	79	47	10.80	2.38	28.0¢
Yolo 28.3"	Check	37	1.23	40				
Karns	N_{82}	71	1.66	117	77	10.96	2.75	17.8¢
	$N_{76}P_{41}$	68	1.42	97	57	14.02	2.75	29.4¢
Average Response	Check	37.3	1.78	64.8				
	"Best Treatment"	90.0	1.78	162.1	97.3	13.44	1.49	15.3¢

B. Grazing Tests with Sheep in 1956

Results of the three grazing tests with sheep are summarized on page 17. All of these tests involve use of nitrogen with sulfur or phosphorus and were laid out to determine effects of fertilization on production of grasses -- particularly for winter and early spring feed.

Carrying capacity both of annual and perennial range was approximately doubled by fertilization. Feed came earlier on fertilized areas and earlier stocking was possible.

The rate of gain of lambs was not appreciably affected by fertilized feed, as both check and fertilized were stocked to the available feed.

Meat production was about doubled by treatment.

These tests have been evaluated on the basis of lamb, mutton and wool produced during the grazing period. Lamb gains are evaluated at selling price of lambs in the test; mutton gains evaluated at a standard value of 5¢ per pound; and the value of the wool clip prorated for the grazing period.

Net profits after deducting fertilizer cost are shown in the last column. It will be noted that Harding grass responded better to fertilizer than annual range in Lake County. In the Marin County tests value of meat and wool exceeded fertilizer cost and fair to good profits are reported.

One treatment of the Lawson test, a February nitrogen application, was made and a severe loss was sustained. This was due to the fact that insufficient animals were available to utilize the great spring flush of growth and the forage became too big for the sheep. A hay crop could have been cut from this experimental field.

VIII. RESULTS OF INDIVIDUAL COUNTY TESTS

Descriptions of the 16 individual county tests, together with record of grazing data and weight records are shown in the pages that follow.

The tests are arranged by counties in alphabetical order.

SUMMARY OF UNIVERSITY OF CALIFORNIA FERTILIZER GRAZING TESTS WITH SHEEP-1956

County Farm and Type Range	Fertilizer Treatment*	"Pair" Days per Ac.	Meat Production: Total lbs/Ac.	Meat Production: Av.Daily gain-Lambs lbs/Day	Evaluation of Results: Total Inc./Ac. Lambs Wool & Mutton	Evaluation of Results: Gain due to Fertilizer	Evaluation of Results: Fertilizer cost/Ac. (applied)	Net Profit per Ac.
Lake Keithley — Native Range	Check	68	54	.54	$10.96			
	N_{84}	140	133	.58	22.58	$11.62	$11.30	.32
Lake Keithley — Harding Grass	Check	121	88	.48	$15.63			
	N_{82}	227	165	.51	31.30	$15.67	$11.21	$4.46
Marin Lawson — Rye Grass Pasture	Check	194	94	.34	20.43			
	$N_{120}P_{50}$	402	222	.39	47.14	26.71	23.63	3.08
	$N_{80}P_{50}$ +N_{70}Feb.	314	129	.33	29.37	8.94	28.53	-19.61
Marin Parks — Seeded Pasture	Check	199	176	.65	33.31			
	$N_{81}P_{42}$	399	296	.64	63.44	30.13	17.65	13.38
Average Values	Check Treatment	146	103	.50	$20.08			
	"Best"	292	204	.53	41.11	$21.03	$15.72	$5.31

* as pounds nitrogen and phosphorus (P_2O_5) applied per acre

ACKNOWLEDGEMENTS

We wish to acknowledge the splendid cooperation of the ranchers who provided the animals and, at extra expense, provided the weighing facilities and specially fenced fields for these tests.

Grateful acknowledgment is also made to the companies whose gifts of fertilizers made these tests possible. A total of 222 tons of materials was furnished by the following companies:

Badische-Aniline, Germany (through Atkins, Kroll) . . . . . Urea

Best Fertilizer Company . . . . . Ammonium phosphate

Brea Chemical, Inc. . . . . Ammonium sulfate and ammonium Nitrate

E. I. duPont de Nemours . . . . . Urea

Mathieson Chemical . . . . . Ammonium phosphate sulfate

Norsk Hydro, Norway (through Wison & George Meyer & Co.) . . . . . Urea

Shell Chemical Corporation . . . . . Urea, Ammonium Sulfate and di-ammonium phosphate

Stauffer Chemical Corporation . . . . . Normal and ammoniated Superphosphates

Sunland Industries . . . . . Amonium sulfate and ammonium phosphate

Western Phosphates . . . . . Treble Superphosphate

MULQUEENEY TEST - Alameda County

Earl Warren Jr. - Farm Advisor

This test was a follow-up utilizing the same fields that were used the two previous seasons. The area was near the village of Midway, nine miles west of Tracy on the eastern edge of the Altamont hills. The two fields fertilized the previous year with different rates of nitrogen were fertilized as a unit of 82 acres with 175 pounds of urea per acre to provide 80 pounds nitrogen per acre. Material was applied by plane at a cost of $1.22 per acre.

The fall rains came early and growth on the fertilized fields started well. In late December the fields were stocked with yearling heifers as in previous years, allowing three acres per animal on the control field of 45 acres and 1.6 acres per animal on the fertilized area.

The late December and early January rains were extremely heavy, totaling somewhat over eight inches of rain, which left the fields in a water-logged condition. The test animals remained on the fields during this period, even though considerable punching from cattle hoofs resulted.

The vegetation stimulated by the three-year program of nitrogen fertilization on the fertilized fields was predominately of the weedy, rapid-growing annual species, principally foxtail and ripgut. These species appeared more aggressive than the wild oats and soft chess which predominated in the unfertilized fields. The aggressive winter annuals in the fertilized fields provided excellent feed during their green state and though grazed closely have assumed dominance in this area.

Beef production per acre was measured by the weight gains of the experimental animals in the 130-day period from December 29 to May 9. On the control 83 pounds of beef per acre were produced in contrast to 140 pounds on the fertilized fields. These figures are approximately the same as from the control fields and the 50 pound nitrogen rate the previous year.

A valuation of the results is made on the basis of the assumed value of the heifers at 18¢ per pound. Using this value the extra beef per acre produced on the fertilized fields was $3.30 less an acre than the cost of the fertilizer. The fertilizer cost per pound of extra beef produced was 23.1¢.

It is felt that the prolonged water logging of the soil at this location caused serious nitrogen loss, since the warm, moist weather in early December had brought about a nitrification of the urea applied. The water-logged condition which prevailed during late December and most of January were just right for de-nitrification and loss of accumulated nitrate nitrogen. The condition of the fertilized field clearly indicated by its pale color a deficit of nitrogen during the latter part of the grazing period.

The results of this test over a three-year period indicate clearly that nitrogen fertilizers may induce a great increase in growth of winter and spring forage at this location. Vigorous growing winter annual grasses are stimulated and outgrow the later maturing annuals more desirable for late spring and dry summer feed. Clearly there was less frost damage on the fertilized grasses than in the control area, but the returns at prevailing cost of beef were not sufficient under the weather conditions existing during the test to pay for the entire cost of fertilization.

MULQUEENEY TEST - Alameda County

130 days, December 29 - May 9

I. TREATMENTS

Nutrients/Ac	None	N80
Materials/Ac	--	175 pounds Urea 45
Fertilizer Cost/Ac	--	
Material		$12.25
Application		1.22
Field Size	45 Acres	82 Acres

II. STOCKING AND GRAZING

Av. In Weight Animals	466	465
Acres Per Animal	3.0	1.64
Grazing Days/Acre	43	79

III. WEIGHT GAINS

Av. Daily Gain	1.92 pounds	1.76 pounds
Beef Production/Ac*	83.0	139.5
Increase from fertilizer		56.5

IV. EVALUATION

Grazing Income/Ac	$14.94	$25.11
Beef @ 18¢		
Increase from Fertilizer		10.17
Less Fertilizer Cost		13.47
Net Loss from Fertilization		$- 3.30

V. FERTILIZER COST PER POUND OF EXTRA BEEF PER ACRE

23.1¢ per pound

*1955 Meat Production	Check	N_{50}	N_{100}
	71.5 pounds	142.9	149.1

SUNLAND TEST - Fresno County

R. G. Jones - Farm Advisor

This test was established approximately ten miles east of Clovis on the terrace flatland lying between the cultivated lands and the foothills. The area had formerly been farmed to dryland grain but had been used as range for the past eight years. Four 50-acre fields were set up, each containing approximately 40 acres of terrace land and ten acres of bottomland formed by a small valley crossing all of the experimental fields.

The test was laid out to compare the effects of a straight nitrogen material with equal nitrogen at increasing rates of phosphorus. This was accomplished by applying 377 pounds of ammonium sulfate to provide 80 pounds of actual nitrogen on one field, with increasing amounts of 16-20 applied to the two other fertilized fields, to give 40 pounds of phosphorus (P_2O_5) on one field and 68 pounds on the fourth field. The soils at this location were clearly deficient in phosphorus on the terrace lands but not in the small area of bottomland included in each field. Growth conditions for forage were favorable during most of the growing season, although drought during February and March reduced growth materially. The addition of phosphorus to nitrogen clearly increased winter growth at this location.

Fall rains came in November in sufficient amounts to start the annual forage rapidly. By December 16 considerable green feed had been produced on the nitrogen-phosphorus fields with a lesser amount on the field receiving the straight nitrogen treatment, and very little on the control field.

Yearling Hereford steers were weighed into all of the experimental fields on December 16. 3.8 acre per animal was used as stocking rate on the control, 2.8 on the straight nitrogen treatment, and 2.5 acres per animal on the two nitrogen-phosphorus fields.

On January 4 additional animals were added to all fertilized fields to utilize the increased forage. On February 6 a further increase in stocking rate was necessary on the two NP fields. The stocking rates on the control remained the same during the entire season. On the high phosphorus field three times the number of animals were carried as on the control during the spring growth period.

The average daily gains of test animals were all good with the highest value in the fertilized fields. The figure of 1.54 pounds/day for the $N_{80}P_{40}$ field may be misleading. Two of the original twenty head placed in this field on December 16 failed to gain for causes unknown. Gains of other groups of steers placed in this field subsequently were equal to gains in the other NP field.

The beef production per acre during the winter period was increased two to three times by fertilization; nitrogen alone doubling production, with the addition of phosphorus causing another doubling of the production obtained in the control field.

The results have been evaluated, using a standard figure of 17.5¢ per pound for beef produced. On this basis the straight nitrogen treatment about paid for the cost of fertilizer and its application. On the high phosphorus field the extra gain was sufficient to pay for the fertilizer, its application, and return a profit of approximately $3 an acre. On the low phosphorus field a loss of $3 was sustained.

Since beef prices fluctuate considerably, the fertilizer cost of the extra beef per acre may be a better basis of evaluation. On this test the extra beef on the straight nitrogen field was produced at a fertilizer cost of 18¢ per pound; that on the low phosphorus field 22¢ per pound; while the high phosphorus field produced meat for slightly below 15¢ per pound.

SUNLAND RANCH - Fresno County

I.	TREATMENTS				
	Nutrients/Ac	Ch	N_{80}	$N_{80}P_{40}$	$N_{80}P_{68}$
	Materials/Ac		377 Am. Sulfate	288 Am. Sulfate 200 16-20	122 Am. Sulfate 340 16-20
	Field Size	50 Ac.	50 Ac.	50 Ac.	50 Ac
II.	STOCKING AND GRAZING				
	Acres per Animal				
	Dec. 16 - Jan. 4	3.8	2.8	2.5	2.5
	Jan. 4 - Feb. 6	3.8	1.9	1.7	1.7
	Feb. 6 - May 3	3.8	1.9	1.5	1.3
	Av. Inc.Wt. Grazing Days/Ac	36.4	69.7	87.2	94.3
II.	WEIGHT GAINS				
	Av. Daily Gain	1.66 lbs.	1.83 lbs.	1.54 lbs.	1.93 lbs.
	Beef Produced/Ac	60.4	128.0	134.0	182.3
	Extra Beef from Fertilizer		67.6	73.6	121.9
IV.	EVALUATION				
	Total Grazing Increase/Ac beef ¢ $17\frac{1}{2}$¢	$10.57	22.40	23.45	31.89
	Less Fertilizer Cost/Ac				
	Material		10.72	14.66	16.61
	Application		1.50	1.50	1.50
	Net Grazing Income	10.57	10.18	7.29	13.78
	Net Profit/Ac from Fertilizer		- .39	- 3.28	3.21
V.	FERTILIZER COST PER POUND				
	Extra Beef/Ac		18.1¢	21.9¢	14.9¢

J. W. SEVIER TEST - Glenn County

Glen P. Eidman - Farm Advisor

This test was a follow-up of the two previous seasons' results at the same location. The experimental area is located approximately 12 miles west of Willows on rolling hills and includes both open grassland and oak-grass woodland. The 200-acre field which had received straight nitrogen from urea the previous season was left unfertilized to study carry-over effects of fertilizer treatment. A 130-acre field fertilized two years previously was re-fertilized with 130 pounds of urea per acre plus 125 pounds of ammoniated Superphosphate. Materials were applied by plane in November of 1955 at a cost of $1.51 per acre.

November rains came in sufficient amounts to start feed early and all fields were stocked with yearling steers on December 15. On January 17 additional animals were added to all fields and this stocking rate maintained for the duration of the test. Carrying capacity was increased nearly $3\frac{1}{2}$ times by fertilization.

The heavy rains which occurred in late December and early January provided ample moisture but the feed production was reduced by the prolonged spring drought which followed the phenomenal winter rains. It was necessary to feed a small amount of hay as supplement to animals on all experimental fields during the dry period.

The total beef production per acre was increased from 30 to approximately 115 pounds per acre by fertilization. The average daily gains were approximately the same in all fields.

The results of this test have been evaluated by using a figure of 18¢ per pound as a reasonable value of the extra beef produced by fertilization. On the field fertilized in 1955 the value of the fertilizer gain was $14.31 per acre, or $1.72 profit after paying for fertilizer costs and its application. The extra beef per acre from fertilization was produced at a fertilizer cost of 15.7¢ per pound.

The field used to measure carry-over effects of previous year's nitrogen produced approximately 14 pounds more per acre than the control. This residual nitrogen effect probably came principally from the areas where fertilized forage had died out in a severe spring drought the previous season, leaving nitrogen for the current season's crop.

A demonstration plot was set up in the corner of the unfertilized field, where various rates of nitrogen with and without phosphorus were applied and harvested by clipping twice during the growing season. The results of these tests showed clearly that nitrogen greatly increased feed production and the protein content of the forage produced during the winter period. Phosphorus neither increased production nor phosphorus content of the forage produced. Soil tests taken in the experimental field and in the fenced-in demonstration area showed the soil to be relatively high in phosphorus, and that phosphorus applications made, probably were ineffective and added to the cost of fertilization without material benefit.

J. W. SEVIER - Glenn County

December 15 - May 17, 1956 - 154 days

		A	B	C
I.	TREATMENTS			
	Nutrients/Ac		$N_{64}P_{20}$	carryover N_{60} in 1955
	Materials/Ac	--	130 urea 46% 125 3-16	urea 1955
	Field Size	365 Ac	133 Ac	200 Ac
II.	STOCKING AND GRAZING			
	Acres/animal			
	Dec. 15-Jan. 17	9.12	3.33	7.69
	Jan. 17-May 17	7.60	2.02	5.00
	Average	7.9	2.2	5.4
	Grazing days/Acre	19.5	70.0	28.5
III.	WEIGHT GAINS			
	Average in weight/animal	451 pounds	504.4 pounds	508.7 pounds
	Average gain in weight	227	231	227
	Average daily gain	1.53	1.63	1.59 pounds/day
	Total beef produced/Acre	29.9	114.6	45.4
	Cost of hay fed/Acre	$ .03	$ .97	$ .37
	Beef @ 18¢ to pay for hay	.17 pounds	5.4 pounds	2.1 pounds
	Beef from pasture alone	29.7	109.2	43.3
	Gain from fertilizer		79.5 pounds	13.6 pounds
IV	EVALUATION			
	Grazing income/Acre from pasture alone (beef 18¢)	$5.35	$19.66	$7.79
	Value of fertilizer gain		14.31	2.44
	Less fertilizer cost/acre		11.08	- 1.60 (less 1955 loss)
	Plane application/acre		1.51	
	Net fertilizer profit/acre		$ 1.72	$ .84
V.	FERTILIZER COST			
	per pound of Extra Beef/Acre		15.7¢ per pound	

KEITHLEY TEST - Lake County

W. C. Lusk - Farm Advisor

The Keithley test was set up to study the effects of fertilization upon meat production of sheep and lamb on an area of rangeland five miles south of Lakeport. This test is particularly interesting, since both native range and improved Harding grass pasture were available in adjacent fields. The object of this test was to measure meat production of sheep on improved Harding grass range and on native pasture, and to observe the effects of fertilization upon both types of range. Previous tests at this location had shown the soil to be deficient in sulfur but adequately supplied with phosphorus. Accordingly ammonium sulfate was applied to one-half of the field of annual range and to a half of the improved Harding grass pasture. Only native legumes were present in the fields.

Rains came early and considerable snow which melted rapidly fell during the months of December and January. In spite of the cold conditions prevailing at this site (elevation 1300 feet) feed on the fertilized fields grew rapidly and the fertilized fields were ready for stocking on February 2. The Harding grass control field made considerable winter growth but only approximately half as much as where fertilized.

The three fields were stocked in proportion to the available feed on February 2. The control field of annual range did not have sufficient feed and stocking was delayed until February 14. On April 13 additional animals were added to all fields.

Carrying capacity of both animal and Harding grass range was doubled by fertilization. Harding grass alone provided twice the number of pair days per acre as the control.

The results of this test have been measured by the meat production of both lamb and mutton during the grazing period. In addition credit has been given for the proportion of wool produced during the grazing period. The lambs from this test went directly to market and were graded into choice and feeder groups at the termination of the test.

The results have been evaluated for the production of choice lamb, feeder lamb, mutton and wool during the grazing period. They are shown on page 25. The annual range produced approximately $11 worth of income per acre in contrast to nearly $16 on the unfertilized Harding grass fields. Fertilization of the annual range doubled production and the increased value was almost exactly equal to the cost of fertilization. The fertilized Harding grass field, however, produced enough extra income per acre to pay for the fertilizer cost and return a profit of $4.47 per acre.

This test is of particular interest, since it shows clearly the increased production possible from improved perennial range where the species present not only produced more feed but also start growth earlier than native pastures. It also shows clearly that the potential for forage improvement and production of winter feed for sheep may be greatly increased by appropriate fertilization of both improved and native pastures in this area. Where early lambs of choice grade bring a good price when ready to go directly to market, fertilization offers a means of providing green feed to lambs and ewes during the late winter and early spring period when green feed is scarce.

KEITHLEY TEST - Lake County - Lambs and Ewes

February 2 - May 15, 1956 - 103 Days

I. TREATMENT	Annual Range (1)	Annual Range (2)	Harding Grass Range (3)	Harding Grass Range (4)
Nutrients/Acre	Check	N_{84}	N_{82}	Check
Materials/Acre	--	401 Am. Sulfate	397 Am. Sulfate	--
Field Size	12.69 Ac.	16.15 Ac.	16.97 Ac	15.64 Ac.
II. STOCKING AND GRAZING				
as "Pair"/Acre				
Feb. 2 & 3 - April 13	--	1.24	2.23	1.02
Feb. 14 - April 13	.47	--	--	--
April 13 - May 15	1.26	1.68	2.23	1.34
"Pair Days"/Acre	68.2	139.7	227.2	121.0
III. WEIGHT GAINS				
Av. gains (lbs/animal day)				
- Lambs	.54 lbs.	.58 lbs.	.51 lbs.	.48 lbs.
- Ewes	.18	.37	.21	.28
Meat produced/Acre-Lambs) (Choice)	35.5 lbs.	65.0 lbs.	92.1 lbs.	49.4 lbs.
" " (Lambs-(Feeder)	6.3	16.5	24.3	5.9
" " Mutton	12.5	51.5	48.6	32.3
Wool (pro rated for grazing period)	1.80	3.53	5.68	2.94
IV. EVALUATION				
Total grazing income				
- Lamb (Choice) @ 23¢	$ 8.17	$14.95	$21.18	$11.36
- Lamb (Feeder) @ 20¢	1.26	3.30	4.86	1.18
- Mutton @ 5¢	.63	2.57	2.43	1.62
- Wool @ 50¢	.90	1.76	2.83	1.47
Total	$10.96	$22.58	$31.31	$15.63
Increase due to Fertilization	--	$11.62	$15.68	--
Less Fertilizer Cost				
Materials		10.30	10.21	
Application		1.00	1.00	
Profit/Acre from Fertilization		$ .32	$4.47	

MCKINNEY TEST - Madera County

Walter Emrick, Farm Advisor

This test was laid out on gently rolling lands approximately five miles east of Madera. The soil is classified as Whitney fine sandy loam, known to be acutely deficient in phosphorus. It was formerly used for grain production. This area of marginal grain land has been used as winter pasture for six years and the plant cover was composed of broadleaf filaree and annual grasses. Two 40-acre fields were set up and one fertilized with 500 pounds of ammonium phosphate sulfate per acre at a fertilizer cost of $22.74 per acre.

Fertilization with the nitrogen-phosphorus material caused a very spectacular increase in winter growth. The fields were ready for stocking by January 10. The control field was stocked at the usual rate of about $4\frac{1}{2}$ acres per animal, while on the fertilized field only 1-1/3 acres per animal were judged to be right for the available feed.

Following the heavy winter rains the feed on the fertilized area grew well. Feed on control area dried up rapidly with the prolonged drought in February and March and the stocking rate had to be greatly reduced on April 21. The high stocking rate was maintained on the fertilized field until May 2. The total number of grazing days per acre was increased from 21 to 88 by fertilization.

Beef production of yearling steers was used to evaluate the results. Animals on the control field gained only 1.5 pounds per day in contrast to nearly 2.2 pounds per day on the fertilized area. Using a beef value of 17¢/pound the grazing income resulting from cattle gains during the 113-day period was increased from $5 to $32 per acre. This increase was sufficient to pay for the high cost of fertilizer applied and leave a profit of $4.30 per acre. The extra beef per acre was produced at a fertilizer cost of $14.3¢/pound.

This test demonstrated strikingly that marginal grain land known to be deficient in phosphorus and depleted in nitrogen through years of cropping may be made to produce large quantities of winter feed if fertilized with sufficient nutrients to really make the forage grow. This area with a relatively mild winter climate has a great potential for production of winter feed. It was strikingly evident that the fertilized forage, particularly the filaree, rooted far more deeply where fertilized, extracted deep moisture and remained green while the same species on the control field had dried up and matured in the spring drought which is common in this area.

MCKINNEY BROTHERS TEST - Madera County

January 10 - May 2, 1956 - 113 days

I. TREATMENTS		
Nutrients/Ac.	None	$N_{80}P_{100}$
Materials/Ac.	--	500 lbs 16-20/Ac.
Field Size	40 Ac.	40 Ac.
Fertilizer Cost Ac.		
- Materials		$22.00
- Application		.74
II. STOCKING AND GRAZING		
Acres/animal		
Jan. 10 - April 21	4.4 Ac.	1.3 Ac.
April 21 - May 2	10.0	1.3
Av. In Wt.	460 lbs.	423 lbs.
Grazing Days/Ac	21.0	87.6
Increase		66.6
III. BEEF PRODUCTION		
Av. Daily Gain		
Jan. 10 - May 2	1.37 lbs.	2.16 lbs.
Jan. 10 - April 21	1.54	
Entire period	1.49	2.16
Beef Produced/Acre	30.1 lbs.	189.2 lbs.
Increase from fertilizer		159.1 lbs.
IV. EVALUATION		
Gross Grazing Income/Ac. (beef @ 17¢)	$ 5.12	$32.16
Less fertilizer cost		22.74
Net grazing increase/ac to	5.12	9.42
Net profit from fertilizer per acre		$4.30
V. FERTILIZER COST		
per pound extra beef/acre		14.3¢/lb.

OLSEN TEST - Madera County

Walter Emrick - Farm Advisor

The Olsen test was set up on Vista rocky sandy loam in an area of typical oak-grass woodland approximately five miles east of Raymond on the road to Coarsegold at an elevation of approximately 1500 feet. Two 80-acre fields were selected for fertilization. Both contained considerable stands of oak and scattered patches of brush. In November the open areas of one field were fertilized with ammonium sulfates at approximately 400 pounds/acre, giving an application over the entire field of 290 pounds.

At this location winter rains came early but extreme cold weather during the month of January and continued drought slowed down the growth of grasses on both the fertilized and control fields. Striking differences in growth were observed as the fertilized grasses rooted more deeply and tapped the underground moisture. On the control field little growth was made during this same period, as the soils remained dry on the surface and grasses did not grow enough to tap the moist soil at lower depths.

Both fields were stocked with yearling steers on February 15, allowing eight acres per animal on the control field and 2-2/3 acres per animal where fertilized. Additional animals were added to the fertilized field on March 25 and again on April 20. The stocking rate during the last month was 1-1/2 acre per animal on the fertilized field where large amounts of forage were produced. Additional animals probably should have been added to the control field.

The average daily gains of the steers employed in this test were approximately two pounds/day on the fertilized fields and 2-1/2 pounds/day on the control field. This would indicate that the control field was probably understocked.

The total beef production per acre was increased from 36 pounds/acre without fertilization up to 141 pounds on the fertilized fields. This latter production is phenominal, since it is based upon the entire acreage, of which approximately 27 percent was occupied by trees and brush.

The results of this test have been evaluated, using a beef price of 17¢/pound. This was sufficient to increase grazing income from $6 to $24/acre, to pay for the fertilizer cost and leave a net profit of $9.18/acre. The extra beef per acre produced by fertilization was made at a fertilizer cost of only 8.2¢/pound.

OLSEN TEST - Madera County

February 15 - June 15, 1956 - 121 days

I. TREATMENT		
Nutrients/Ac	None	N60
Materials/Ac	--	290 Am.Sulfate/Ac
Fertilizer Cost		
- Materials	--	$8.03
- Application	--	.47
Field Size	80 Ac	80 Ac
II. STOCKING AND GRAZING		
Acres/animal		
Feb. 15 - March 25	8.0 Acres	2.67 Acres
March 25 - April 20	8.0	2.00
April 20 - June 15		1.33
Av. In wt/animal	475 lbs.	553 lbs.
Grazing days/acre	14.6	69.8
Increase from fertilizer		55.2
III. WEIGHT GAINS DURING TEST		
Av. Daily Gains		
Animals in Feb. 15 - June 15	2.54	2.12
" " March 25 - June 15	--	1.84
" " April 20 - June 15	--	1.83
Average of all animals	2.54	2.03
Beef Produced/Ac	37.1 lbs.	141.1 lbs.
Increase from Fertilizer		104.0
IV. EVALUATION		
Total Grazing Income/Ac beef @ 17¢	$6.31	$23.99
less fertilizer cost/Ac		8.50
Net grazing income/Ac	6.31	15.49
Net profit/Ac from fertilizer		9.18
V. FERTILIZER COST		
per pound extra beef/Acre		8.2¢ per lb.

URRUTIA TEST - Madera County

Walter Emrick - Farm Advisor

This test was a continuation of the test carried out the previous season at the same location. It was located approximately five miles west of Friant Dam in brush-free open range on soil mapped as Vista fine sandy loam. Forage was composed of native grass of filaree with considerable amounts of native clover. Previous tests had shown this soil to be acutely deficient in sulfur but not responsive to added phosphorus. A ten-acre field fertilized in the 1955 season was used to measure carry-over effects of the ammonium sulfate applied. The 1955 control field was enlarged to 40 acres and treated with an application of 380 pounds ammonium sulfate per acre. An adjacent 120-acre field was used for control.

As in the previous season, the application of ammonium sulfate caused a very striking stimulation of grass growth during the winter and spring months. The carry-over field showed striking stimulation of native clovers. This response is believed due to the residual effects of the sulfur applied in the ammonium sulfate the previous year.

All fields were stocked with yearling steers on February 1, allowing three acres per animal on the control; 2.7 acres on the carry-over field. One animal per acre went on the newly fertilized field treated with ammonium sulfate. On March 27 so much additional growth of clovers was evident on the carry-over field that the number of animals was doubled, bringing the stocking rate up to 1.3 acres per animal. The carrying capacity was increased three-fold by the current fertilizer treatment and almost doubled by the carry-over effects of the previous year's fertilization.

The average daily gains of animals in this test was about the same in all experimental fields.

The total beef production was increased from 80 pounds/acre on the control to 256 pounds on the field currently fertilized. The beef production on the carry-over field was almost double that of the unfertilized.

The results of this test have been evaluated, using a figure of 17¢/pound, for the cattle gains during the grazing period. On this basis the fertilized field returned $18.02/acre profit after paying for the fertilizer and its application. The carry-over field produced $12 worth of beef more than the control field.

The extra beef produced on the current fertilized field was produced at a fertilizer cost of 6.8¢/pound. The carry-over field, which had shown a substantial profit on first year's performance, produced 233 more pounds of beef per acre in the two seasons than did the control. This extra beef on a two-year basis was produced for a total cost of only 5.1¢/pound.

The carry-over effects of ammonium sulfate at this location were very striking, and point the way toward effective means of both increasing winter feed resources through grass stimulation and in stimulating increased clover growth in subsequent years. Throughout much of the foothill area of Madera area sulfur is deficient. If ammonium sulfate applications continue to produce enough feed the first year to pay for cost of fertilization, the long-term improvement in increasing the sulfur status of the soil, comes free and helps build up a desirable clover population in the subsequent years.

URRUTIA TEST - Madera County

February 1 - June 15, 1956 - 136 Days

I. TREATMENT			
Nutrients	None	N_{80} 1955 carry-over	N_{80}
Materials/Ac	--		380 Am. Sulfate
Field Size	120 Ac	40 Ac	40 Ac
II. STOCKING AND GRAZING			
Acres/animal			
Feb. 1 - March 27	3.0	2.7	1.0
March 27 - June 15	3.0	1.3	1.0
Av. In Wt./animal	445	508	445
Grazing days/acre	45.3	81.0	136.0
Increase from fertilization		35.7	90.7
III. BEEF PRODUCTION			
Av. Daily Gains	1.75 lbs.	1.86 lbs.	1.86 lbs.
Av. gain/animal	238	200	256
Beef produced/Ac	79.4	150.1	255.9
Gain from fertilization		70.7 lbs. (162.7 in 1955)	176.5 lbs.
IV. EVALUATION			
Gross Grazing Income/Ac beef @ 17¢	$13.50	$25.56	$45.52
Less fertilizer cost			
Material			11.26
Application			.74
Net grazing income/Ac	$13.50	$25.56	$31.52
Net profit from fertilization		$12.06	$18.02
V. FERTILIZER COST			
per lb extra beef/acre		5.1¢/lb. (2 years)	6.8¢/lb. for 1956

* Beef Production lbs/Ac in 1954-55	Control	380 Am.Sulfate
	44.3 lbs	207.3 lbs

LAWSON TEST - Marin County

W. L. Engvall - Farm Advisor

This test was a continuation of the one carried out on the same fields the previous year. The area was located on open pasture land in the rolling hills above Dillon's Beach, near the mouth of Tomales Bay. A ryegrass pasture had been divided into three fields. Two of these in 1954-55 had received ammonium phosphate. These same two fields were re-fertilized in November 1955 with a uniform application of 265 pounds of Superphosphate. In addition one received 80 pounds of nitrogen from urea and the other 120 pounds of nitrogen from the same material as the fall application.

Growth came rapidly on the fertilized fields but slowed down considerably after very heavy rains in late December and early January. The field with the lighter rate of nitrogen became quite yellow, indicating nitrogen loss by leaching. A second application of urea was made to this field in early February.

All fields were stocked with lambs and ewes on January 30. 1.5 pairs per acre went on the control; two pair per acre on the 80 nitrogen field and 3.5 pair per acre on the field receiving the high nitrogen rate.

Carrying capacity was doubled by the high fall nitrogen treatment. The fields which received the split application of nitrogen produced a phenomenal amount of growth during the spring months. Much of this growth was wasted for the current test, since insufficient numbers of animals were available to put in this field. As a result the ryegrass "got away" and became too large and unpalatable for use by the sheep in this field. Clippings showed an excess of 4000 pounds of forage per acre were left in this field.

The results of this test have been evaluated, using the market value of lambs at the conclusion of the trial and by giving the gains in weight of the ewes a value of 5¢ per pound. In addition each field was credited with its proportion of the animal wool clip. On this basis the $N_{120}P_{50}$ field produced enough extra income to pay for the fertilizer cost and return a net profit of $3 an acre. The field with the split application of nitrogen where extra forage was not utilized showed a loss of approximately $20.

Phosphorus was applied to both fertilized fields, since clipping tests the previous season had shown a clear response to this nutrient. Actually the use of phosphorus was unnecessary in 1956 because of the carry-over effect of the previous phosphorus application as shown on page 33.

Demonstration plots with two rates of nitrogen and four rates of phosphorus were set up in the fall of 1955 on a field fertilized with nitrogen and phosphorus the previous year. A similar test had been carried out on unfertilized land in 1955. The results of both seasons' forage yields as determined by clipping are shown on page 33. In 1955 there was a striking response to added nitrogen but further increase where phosphorus was applied. In 1956, however, the soils had sufficient carry-over effect of fertilizer applied the previous year so that no effect of added phosphorus was evident. The responses to nitrogen, however, were very striking. It is interesting to note that in 1955 a maximum of 55 to 65 percent of the fertilizer nitrogen was recovered in the two clippings of forage made. The application of phosphorus increased the efficiency of nitrogen recovery. In 1956 only 36 to 37 percent of the fertilizer nitrogen was recovered and no effect of phosphorus was noted, either on yield or percent recovery of added nitrogen.

In view of the carry-over effects of phosphorus established by the 1956 clipping tests, it would appear clear that phosphorus applications costing $5 per acre in the grazing test could have been eliminated with equally good animal performance and a $5 higher profit.

SUMMARY OF LAWSON'S GRAZING TEST

Marin County - January 30 - June 12, 1956 - 134 Days

		A(10 Ac)	B(10 Ac)	C(10 Ac)
I.	TREATMENTS		Oct.	Oct. Feb.
	Nutrients/acre	none	$N_{120}P_{50}$	$N_{80}P_{50}$ + N_{70}
II.	STOCKING AND GRAZING			
	Pair/acre -			
	Jan. 30 - May 12	1.5	3.2	1.9
	May 2 - June 12	--	2.2	3.2
	Pair Days/acre - Lambs	194	402	294
III.	WEIGHT GAINS			
	Av. Daily Gain - Ewes	.138 lbs	.148 lbs	.105 lbs
	" " " Lambs	.343 lbs	.393 lbs	.327 lbs
IV.	MEAT PRODUCED/ACRE			
	Ewes	27.7 lbs	59.7 lbs	33.0 lbs
	Lambs	66.4	162.5 lbs	96/0 lbs
	Wool Produced/acre	8.5 lbs	16.7 lbs	12.6 lbs
V.	EVALUATION			
	Lamb @ 21¢	$13.94	$34.13	$20.16
	Mutton @ 5¢	1.39	2.99	1.65
	Wool @ 60¢	5.10	10.02	7.56
	Total Grazing Income	$20.43	$47.14	$29.37
	Fertilizer Gain		26.71	8.94
	Fertilizer Cost/Acre		23.63	28.55
	Net Profit/Acre		$ 3.08	$ -19.61

DIRECT AND CARRY-OVER EFFECTS OF NITROGEN AND PHOSPHORUS FERTILIZERS ON FORAGE YIELDS

1955 Results on Field Previously Unfertilized			1956 Results on Field Fertilized with $N_{64}P_{40}$ in 1955				
1955 Fert. Treat.	Yields of Forage lbs/dry wt./ac.	Percent Nitrogen Recovery	1956 Fert. Treat.	Yields of Forage lbs/dry wt./ac.	Average Yield	Uptake of N.	Percent Nitrogen Recovery
Check	438		Check	509	509	8.1	
N_{64}	1251	25%	N_{80}	1975			
$N_{64}P_{20}$	1592	48	$N_{80}P_{25}$	2270			
$N_{64}P_{40}$	1958	49	$N_{80}P_{50}$	1875	2008	38.8	37.4%
$N_{64}P_{80}$	2230	65	$N_{80}P_{100}$	1915			
N_{128}	2200	32%	N_{128}	2836			
$N_{128}P_{20}$	2295	35	$N_{128}P_{25}$	2616			
$N_{128}P_{40}$	3285	58	$N_{128}P_{50}$	2470	2694	54.1	35.9%
$N_{128}P_{80}$	3214	53	$N_{128}P_{100}$	2861			

THE PARKS TEST - Marin County

W. L. Engvall - Farm Advisor

This test is a continuation of one carried out in 1955 as a 4-H Club project. The area selected was on improved range about a mile north of the town of Tomales. In 1954-55 two small fields of two acres each were set up in a fertilizer test using sheep to measure results. The same two fields were used in the current season. The first season the treated field received 500 pounds of 16-20 per acre. Sufficient extra meat was produced the first year to pay for the fertilizer cost and leave a small profit.

In November of 1955 the same fertilized field received an additional application of 300 pounds of 27-14 to provide 81 pounds of nitrogen and 42 of phosphorus.

As in the previous year a phenomenal growth of forage was produced during the winter months. On January 24 both fields were stocked, but twice as many animals were put into the fertilized field. The lambs and ewes remained in these fields until June 6, at which time all lambs were marketed. All lambs in the test graded as fat lambs and went for the premium price of 24¢ per pound. Ewe gains were evaluated at 5¢ per pound. No credit was taken for wool production.

The increased income per acre in this test was approximately $30 per acre, with a fertilizer cost of only $16.75. This left a net profit of $13.38 per acre.

This test carried out by a farmer cooperator is included in this study because it illustrates the fact that fertilization of good improved pastures may greatly increase the income from such lands. Feed was closely cropped, yet it remained nutritious and when grazed by good quality sheep produced a fine crop of fat lambs.

The area around Tomales is one where rainfall and temperature are normally particularly favorable for the production of winter feed, and one of the areas where spring rains continue almost until summer. Temperatures rarely drop low enough during the winter period to seriously slow down the growth of forage, if readily available nitrogen and sufficient phosphorus are available to the growing plants.

PARKS TEST - Marin County

January 24 to June 6, 1956

I.	**TREATMENTS**		
	Nutrient/Acre	Check	$N_{81}P_{42}$
	Materials/Acre	--	300 lbs 27-14-0
	Field Size	2 Acres	2 Acres
II.	**STOCKING AND GRAZING**		
	Pairs/Acre	1.5	3
	Grazing days/Acre		
	Lambs	199	399
	Ewes	199	399
III.	**WEIGHT GAINS**		
	Gain/Acre - Lambs	129 lbs.	256 lbs.
	" " Ewes	47	40
IV	**EVALUATION**		
	* Lamb @ 24¢	$30.96	$61.44
	Mutton @ 5¢	2.35	2.00
		$33.31	$63.44
	Fertilizer Gain		30.13
	Fertilizer cost @ $105/ton		15.75
	Cost of application		1.00
	Net Profit/Acre		$13.38

* All Lambs graded prime.

ALRICH TEST - Placer County

Walter Johnson - Farm Advisor

This test was set up on an area of Placentia sandy loam some six miles north of Lincoln. Several fields were available which had been planted with improved annual clovers five years previously. All fields had received some Superphosphate three years earlier. A good stand of rose and subterranean clover existed, along with annual grasses and filaree. Four demonstration fields were set up; one as a control, one with 258 pounds of Superphosphate, a third with 567 pounds of Superphosphate and a fourth field with 258 pounds of Superphosphate plus urea to provide 70 pounds of nitrogen. Materials were applied in October. Growth of forage started with the November rains and continued rapidly on the nitrogen-phosphorus field. The seeded legumes and annual grasses on the control and straight phosphorus fields made very little growth until March. The nitrogen-phosphorus field was ready for grazing by mid-January but animals were not put in until February 17 because of the water-logged condition of the soils resulting from the very heavy winter rains. The control field and straight phosphorus field were not stocked until early April. Grazing continued on all experimental fields until May 22, when animals were removed to allow the annual clovers to set seed. The control field and the light phosphorus field had more dry feed remaining than the other fields, so cows and calves were put in these fields in June and July to equalize the dry feed in all of the four fields.

The average daily gains of steers employed in the green feed period were greater on the phosphorus fields than on the control and both of these in excess of the rate of gain on the nitrogen-phosphorus field.

The total beef production per acre during the green feed period was increased from 81 on the control to 202 pounds on the nitrogen-phosphorus field. The two straight phosphorus fields produced 130 to 180 pounds of meat. The additional meat yields of cows and calves in June and July on the control and light phosphorus field increased their meat yields materially.

The results of this demonstration have been evaluated, using steer gains at 17¢ per pound, cow gains at 11¢ per pound and increases of calf weight at 18¢ per pound. The resultant net income from pasture was sufficient to show a net profit of $6.69 per acre on the light phosphorus field, $2.64 on the heavy phosphorus field and $1.47 on the nitrogen-phosphorus field, which was grazed over a much longer period. It is expected that very substantial carry-over of added phosphorus will be obtained in the next season. The fertilizer cost on a single season's basis may not be a true evaluation of results. However, the fertilizer cost of the extra beef produced per acre was only 6.5¢ per pound on the light phosphorus field; 13.3¢ on the high phosphorus and 15¢ where both nitrogen and phosphorus were employed.

It should be pointed out that the use of straight phosphorus fertilizers on improved clover range is a very effective means of increasing spring forage and of improving the quality of dry feed for summer and fall use. In this test, however, grazing was not possible upon these fields until April, while on the nitrogen-phosphorus field forage for animals was available in February. Certainly animals waiting for annual clover pastures to become ready for grazing would have to be held elsewhere or fed substantial amounts of hay during the winter months.

ALRICH TEST - Placer County

February 17 - May 22, 1956 - Green Feed Period

June 12 - July 26, 1956 - Dry Feed Period

I.	TREATMENTS	#4	#3	#2	#1
	Nutrients/Acre	Control	P_{49}	P_{109}	$N_{70}P_{49}$
	Materials/Acre		258 S.Super.	567 S.Super	258 S.Super
	Field Size	124 Ac.	84 Ac.	63 Ac.	32 Ac.
II.	STOCKING AND GRAZING				
	First Grazing	April 7	April 7	April 7	Feb. 17
	Acres/Animal				
	Green Feed Period-(Steers)	--	--	--	1.18 Feb.& Mar.
		1.13	.76	.61	.57 Apr.& May
	Dry Feed Period - (Cows & Calves)	3.10	.92	--	-- June,July
	Grazing Days/Acre (Green Feed Period)	40	58	73	117
	Grazing Days/Acres (Dry Feed Period)	16	33		
III.	WEIGHT GAINS				
	Av. Daily Gain/animal				
	Green Feed - Steers	2.02 lbs.	2.46 lbs.	2.46 lbs.	1.72 lbs.
	Dry Feed - Cows	1.00	.94		
	Dry Feed - Calves	1.37	1.78		
	Total Beef Produced/Ac				
	Steers	81	131	179	202
	Cows	9	18	-	-
	Calves	10	24	-	-
	Total	100	173	179	202
	Extra Beef from Fertilizer		73	79	102
IV.	EVALUATION				
	Value of Beef Produced	$16.58	$28.51	$30.43	$34.34
	Less Fertilizer Cost				
	Material		4.77	10.49	15.32
	Application		.50	.75	1.00
			$23.24	$19.19	$18.02
	Net Income from Pas.	16.55			
	Profit/Ac from Fert.		$ 6.69	$ 2.64	$ 1.47
V.	FERTILIZER COST/POUND OF "EXTRA BEEF"/ACRE		6.5¢	13.3¢	15.0¢

VAN VLECK TEST - Sacramento County

James Elings - Farm Advisor

This test was a continuation of one carried out in 1955. The area was located on open rangeland near Michigan Bar in eastern Sacramento county. A 160-acre field composed of principally Pentz loam and Peters adobe clay with lesser amounts of Redding gravelly loam had been divided into four parts; 70 acres as a control and three 30-acre fields all fertilized the previous season. Results had shown good grass growth and meat production where nitrogen and phosphorus were applied but with poorer results from nitrogen alone.

The fertilizers were applied by planes on October 2. Field A, which had received both nitrogen and phosphorus the previous year, again received a nitrogen-phosphorus treatment of urea and treble superphosphate to provide 74 pounds of nitrogen and 50 pounds of P_2O_5. Field B, which had received nitrogen and phosphorus the previous year, got only an application of 74 pounds of nitrogen. This treatment was set up to demonstrate whether it is necessary to reapply phosphorus annually. Field C, which had a straight nitrogen treatment the previous year, was left unfertilized, as was the original control field. Fall rains came early and the feed started rapidly on both the straight nitrogen and the nitrogen-phosphorus fields, indicating that there was a considerable carry-over of phosphorus. In a fenced exclosure where several rates of nitrogen and phosphorus were applied, virtually no growth during the winter months was made when nitrogen was applied without phosphorus.

All four fields were stocked with yearling steers on December 27, the control at six acres per animal and Field C 50 percent heavier or four acres per animal. A supplement was provided in self-feeders for the animals in this field. Field A, with the heaviest fertilizer treatment, was stocked at the rate of two acres per animal; while Field B, the phosphorus carry-over field with nitrogen only in 1955, had three acres per animal. On January 18, the stocking rate in all fields was increased.

Animals were weighed when placed in the field, at two dates during the test, and again at the conclusion. Weight gains during the first period from December 27 to March 16 are of particular interest. Animals receiving supplement gained almost exactly the same per head as did those on the best fertilizer treatment. Animals in the control field gained the least. In the second period from March 16 to May 10, all animals gained in excess of two pounds per day, with the least rate of gain in the control field. In the final period from May 10 to June 8, animals in the control field outgained animals in all other fields. The weight gains during this final period were related to rate of stocking. Where a heavier stocking rate was employed the cattle gained less per day. It should be noted, however, that while animals on the control gained more per day, the beef production per acre during this period was only about half of that on the fertilized fields.

The beef production per acre in this test was increased from 53 on the control up to over 180 pounds on the field currently fertilized with both nitrogen and phosphorus. The field which received nitrogen only following phosphorus the previous year produced somewhat less beef. Production on the field where the animals received supplement during the winter months was almost double that of the control.

The results of this test have been evaluated with beef at 17½¢ per pound. On this basis the highest profit was obtained where both nitrogen and phosphorus were applied. Profit per acre on the supplement field and straight nitrogen field after deducting costs of supplement and fertilizer was almost exactly the same.

The fertilizer cost of the extra beef produced was approximately 13¢ per pound on both fertilized fields. The extra beef on the supplement field was produced for a cost of 8.3¢ per pound.

VAN VLECK TEST - Sacramento County

December 27, 1955 - June 9, 1956 - 168 Days

		D	C	B	A
I.	TREATMENTS				
	Nutrients/Acre (1955 Treatments)	None	Supple.only (N_{73})	N_{74} $N_{73}P_{49}$	$N_{74}P_{50}$ (N_{59} P_{79})
	Materials/Acre	--	--	160 lbs Urea(46%)	160 lbs Urea (46%) 107 Treb.Sup.
	Field Size	70 Ac.	30 Ac.	30 Ac.	30 Ac.
II.	STOCKING AND GRAZING				
	Av. In Weight/Animal	486 lbs	459 lbs	479 lbs	469 lbs
	Acres/Animal				
	Dec. 27 - Jan. 18	5.8	4.3	3.0	2.0
	Jan. 18 - June 8	4.7	3.0	1.9	1.4
	Grazing Days/Acre	34.3	52.8	83.7	111.0
III.	WEIGHT GAINS				
	Av. Daily Gain/Animal				
	Dec. 27 - March 16	.77 lbs.	1.19* lbs.	1.18 lbs.	.88 lbs.
	March 16 - May 10	2.11	2.54	2.33	2.66
	May 10 - June 8	2.45	2.09	1.83	1.58
	Entire Season	1.55	1.83	1.73	1.63
	Weight Gains/Animal	248	290	271	259
	Beef produced/Acre				
	Dec. 27 - March 16	12.4	28.8*	44.8	45.0
	March 16 - May 10	24.9	46.5	69.7	102.3
	May 10 - June 8	15.9	21.3	30.0	33.9
	Entire Season	53.2	96.7	144.5	181.2
	Increase from Fertilization or Supplement		43.5	91.3	128.0
IV.	EVALUATION				
	Grazing Income/Acre Beef @ 17½c	$ 9.31	$16.92	$25.29	$31.71
	Less Fertilizer Cost/Ac.		(3.63)	10.40	14.88
	Materials		(Supplement)		
	Application			1.45	2.08
	Net Grazing Income	$ 9.31	$13.29	$13.44	$14.75
V.	FERTILIZER OR SUPPLEMENT COST OF EXTRA BEEF/ACRE		8.3¢	13.0¢	13.2¢

* Supplement fed December 27 - March 16. Supplement cost of the extra 16.4 pounds beef per acre in this period only, was 22.1¢/pound

THE BECKLEY TEST - San Joaquin County

H. A. Moore - Farm Advisor

This test was set up in the fall of 1955 on an area of open range six miles southeast of Linden. An 160-acre field composed principally of San Joaquin loam, Redding gravelly loam and Bear creek loam was divided into two 40-acre fields for treatment and an 80-acre field as control. The first field received 80 nitrogen and 38 P_2O_5 from 420 pounds of a 19-9 ammonium phosphate per acre. The second field received the same 80 nitrogen but with 80 pounds P_2O_5 per acre from application of 400 pounds per acre of 20-20 nitric phosphate - half of the nitrogen ammoniacal, half as nitric nitrogen.

Growth started rapidly on these fields, which were composed of filaree, burr clover and native annual grasses. No difference could be seen between the two fertilized fields which received different phosphorus rates. The fact that one field received half nitric nitrogen and the other all ammoniacal nitrogen seemed to make no difference. The fields were ready for stocking in early January, but because of the very heavy rains were judged too water-logged until mid-February.

On February 15 all fields were stocked with replacement dairy heifers; 3.2 acres per animal were allowed on the control field, while both fertilized fields were stocked at one animal per acre. These same stocking rates were maintained until the test was terminated on May 22.

Weight gains during this test were almost exactly the same on the two fertilized fields and these very little more than on the control. Beef production per acre was increased from 50 pounds per acre on the unfertilized field to 170 pounds on the two fertilized fields.

The results of this test have been evaluated at 16¢ per pound, a fair rate for gains on dairy replacement heifers. On this basis the field which received 80 nitrogen and 38 phosphorus from an ammonium phosphate showed a net profit of $2.04 per acre after paying the cost of fertilizer and its application. The second field, which received 80 nitrogen and 80 phosphorus from nitric phosphate, showed a net loss of 60¢ per acre after deducting the higher cost of fertilizer supplied through this field.

The fertilizer cost per pound of extra beef produced by fertilization on these fields was 14.3¢ per pound where 80 nitrogen and 38 phosphorus were applied, and 16½¢ per pound of nitrogen and 80 phosphorus were applied as nitric phosphate.

BECKLEY TEST - San Joaquin County

February 15 - May 22, 1956 - 86 Days

		A	B	C
I.	TREATMENTS			
	Nutrients/Acre	$N_{80}P_{38}$	$N_{80}P_{80}$	Control
	Materials/Acre	420# 19-9-0	400# 20-20-0	None
	Fertilizer Cost/Acre	$17.05	$19.00	None
	Field Size	40 Acres	40 Acres	80 Acres
II.	STOCKING AND GRAZING			
	Acres/Animal	1.0	1.0	3.2
	Animal days/Acre	86	86	26.88
	Increase	59.12	59.12	
III.	WEIGHT GAINS			
	Average In Weight	463.25 lbs.	454.75 lbs.	474.8 lbs.
	Average Out Weight	632.75	625.00	635.6
	Average Increase	169.50	170.25	635.6
	Average daily gain	1.77	1.77	1.68
	Total beef produced/Acre	169.50	170.25	50.25
	Gain due to Fertilization	119.25	120.0	
IV.	EVALUATION			
	Total Grazing Income/Acre			
	Beef @ 16¢	$27.12	$27.24	$ 8.04
	Beef @ 18¢	30.51	30.65	9.05
	Less Fertilizer Cost/Acre			
	Materials	$16.24	$19.00	-
	Application	.80	.80	-
	Net Income/Acre			
	Beef @ 16¢/lb	$10.08	$ 7.44	$ 8.04
	Profit from Fertilization	2.04	- .60	-
V.	FERTILIZER COST/LB. OF EXTRA BEEF/ACRE	14.3¢	16.5c	

CROWE TEST - Shasta County

Walter Spivey - Farm Advisor

This test was set up in the fall of 1955 on rolling open range land five miles east of Millville. The two fields were fertilized by plane on October 17 with mixtures of ammonium sulfate and diammonium phosphate to provide 80 pounds of nitrogen per acre to both fields, with 50 pounds P_2O_5 on one field and 100 pounds per acre on the second. The phosphorus-rate experiment was set up because previous tests in this area had indicated a wide-spread deficiency in phosphorus. Soil samples taken prior to the test had indicated a low phosphorus status using the soil phosphorus deficiency values available at that time. Fall rains came early and the growth started well on both fertilized fields. In December and January, 29 inches of rain were recorded at the nearest weather station at Redding. These extremely heavy rains caused a very substantial loss of applied nitrogen. Tests in small plots indicated only a slight response to added nitrogen and no measurable response to phosphorus alone or in combination with nitrogen.

All experimental fields were stocked on February 16 with Hereford heifers of assorted weights ranging from 400 to 700 pounds. All animals were weighed individually.

The number of grazing days per acre was increased from 25 to 70 on the best fertilized treatment. Animals were shifted from one fertilized field to the other in an effort to equally utilize the available feed and additional animals were added to the control field during the spring flush of growth. The average daily gains of the test animals were greater on the control field than on either of the fertilized fields. It will be noted that the average daily gain was greatest where the stocking rate was lightest and least where the stocking rate was the highest. Beef production per acre, however, was almost exactly doubled by fertilized treatments, with no difference between the fields receiving the different rates of phosphorus.

The results of this test have been evaluated, using an arbitrary value of 17¢ per pound for the beef produced during the grazing period. On this basis the increased beef production from fertilization was worth only approximately $9 per acre of the two fertilized fields. This was very much less than the cost of fertilizer and substantial loss resulted from the operation.

The results of this test were disappointing. Clearly where rainfall of nearly 30 inches falls in a period of two months substantial losses of added nitrogen may be expected. The cost of the added phosphorus, which now appears to have been unnecessary, further increased the loss for the whole operation. The loss of fertilizer nitrogen under conditions of high winter rainfall is clearly a hazard which may occasionally be met, although weather records would indicate little likelihood that rainfall of this magnitude would occur very frequently.

Crowe Test - Shasta County

February 6 - May 24, 1956 - 108 Days

I	TREATMENTS			
	Nutrients/Acre	None	N P	N P
	Materials/Acre	--	286 Am.Sulf. 94 DiAm.Phos.	195 Am.Sulf. 185 DiAm.Phos.
	Fertilizer cost/Acre			
	Material		$15.42	$20.10
	Application		2.40	2.43
	Field Size	94 Acres	40 Acres	47 Acres
II	STOCKING AND GRAZING			
	Acres/Animal			
	February 16 - March 17	9.4		2.1
	March 17 - April 26			1.6
	April 26 - May 24			2.7
	Grazing Days/Acre	25	70	52
III.	WEIGHT GAINS			
	Average Daily Gain	2.33 lbs.	1.63 lbs.	2.08 lbs.
	Beef Produced/Acre	57	114	108
	Increase from Fertilizer		57	51
IV.	EVALUATION			
	Grazing Income/Acre			
	Beef @ 17¢	$9.69	$19.38	$18.08
	Increase from Fertilizer		9.69	8.67
	Less Fertilizer Cost		17.82	22.53
	Loss from Fertilizer/Acre		- 8.13	- 13.86
V.	FERTILIZER COST/POUND OF EXTRA BEEF/ACRE		31.3¢	44.2¢/pound

LAWLER TEST - Solano County

Arthur Swenerton - Farm Advisor

This test is a continuation of the demonstration carried out at the same location during the previous two seasons. The same control field was used as in the past. A field of 66 acres not fertilized the previous year received an application of 228 pounds ammonium nitrate per acre to provide 76 pounds of nitrogen. Two fields fertilized the previous year with ammonium sulfate and calcium nitrate were left unfertilized to measure the carry-over effect of these materials.

Rains came early and the feed on the currently fertilized field started rapidly. In late December and early January a total of 21.6 inches of rain fell. The soils at this location have an impervious subsoil with the result that water ponded and remained as small lakes for at least a month on portions of the carry-over fields and field currently fertilized.

All experimental fields were stocked on January 27 with animals which had been held in water-logged and flooded fields elsewhere on the ranch. These young heifers and steers weighed approximately 340 pounds each and were in very poor condition. Some died from disease contracted earlier during their exposure to flood conditions. The weight of these animals was deducted from initial weights.

The animals carried through to completion of this test showed good gains of approximately 1-3/4 pounds per day and very high beef production per acre. The beef production per acre both on the control and currently fertilized fields was high. This may be attributed to the fact that all animals were in poor flesh at the beginning of the test. The increased beef production per acre on the fertilized field was only 36 pounds more than on the control. This small increase due to fertilization may be attributed to the long water-logging of the experimental field which caused losses by leaching and de-nitrification of the nitrate applied.

Results on the two carry-over fields are not shown. These fields had small-sized lakes on them and forage in these long-flooded areas dies out. Since no accurate measure of the area of the "lakes" was possible, the weight gains on these fields are not included in this report. They were, however, substantially less than the beef production on the control field.

The results of this test are evaluated, using a figure of 17½¢ per pound, as a reasonable value of the beef produced. On this basis the value of the increased beef production was nearly $6 per acre less than the cost of the fertilizer and its application. If we are to assume that the nitric half of the nitrogen present in the ammonium nitrate form was completely lost by the flooding conditions, then the remaining ammoniacal half of the nitrogen would have been almost exactly paid for by the extra beef produced.

LAWLER TEST - Solano County

January 27 - May 30, 1956 - 124 Days

I.	TREATMENTS	A	D
	Nutrients/Acre	--	N_{76}
	Materials/Acre	--	278 Am. Nit.
	Field Size	92 Ac.	66 Ac.
II.	STOCKING AND GRAZING		
	Acres/Animals		
	Jan. 27 - Feb. 9	1.38	1.00
	Feb. 9 - May 31	1.13	.93
	Grazing Days/Acre	106	130
II.	WEIGHT GAINS		
	Av. In Weight	344 lbs.	339 lbs.
	Av. Out Weight	565	551
	Av. Daily Gain	1.82	1.74
	Total Beef produced/Acre	192.0	227.6
	Increase due to Fertilization		35.6
IV.	EVALUATION		
	Total Grazing Income @ 17½¢ beef	$33.60	$39.42
	Value of fertilization increase		5.82
	Less cost of fertilizer material		9.88
	Less application cost		1.82
	Net loss/Acre		5.82
	Fertilizer material cost/pound increased beef yield		27.6¢/pound

REDWOOD TEST - Sonoma County

George Stanley - Farm Advisor

This test was set up in the fall of 1955 on the rolling hills between Petaluma and Sonoma. The area was one of grass oak woodland with approximately 30 percent of the area covered with clumps of oak and California laurel. The grass present was principally soft chess and wild oats with a considerable amount of subterranean clover seeded there some six years previously. A 90-acre field was fertilized by plane in October with a mixture of ammonium sulfate and diammonium phosphate to provide 59 pounds nitrogen and 33 pounds P_2O_5.

Rains came early at this location and the growth on the fertilized fields started rapidly. Growth on small plots set up in a fenced exclosure showed clearly that both nitrogen and phosphorus must be applied at this location. In late December and January very heavy rains fell and completely saturated the soil. Records from the Petaluma weather station indicate that an excess of 25 inches of rain fell. Growth slowed up and fields became temporarily yellow, indicating a loss of applied nitrogen.

All fields were stocked on January 20 with spayed yearling Hereford heifers. The control field was stocked at rate of six acres per animal as compared to two acres per animal on the fertilized field. Following the winter rains a period of spring drought set in and it was necessary to remove some of the animals from the fertilized fields on April 2. Late rains revived the feed and good grass growth was made during the last few weeks of the test. Unfortunately the test animals were sold and removed on May 23, when there was ample feed to continue the test several weeks longer.

The weight gains of experimental animals in this test was almost the same on the control and fertilized fields. Beef production per acre was increased from 32 pounds per acre up to nearly 79 pounds on the fertilized fields.

The results of this test have been evaluated, using a figure of 17¢ per pound as a fair one for the value of the Hereford heifers used in this test. Using this figure a net loss of $5.30 per acre resulted from the operation. A considerable amount of this loss may be attributed to loss of nitrogen by leaching during the winter flood period. An inspection of the fields in early June revealed that large amounts of feed on the fertilized field had not been utilized. The sale of the experimental animals and removal on May 23 was unfortunate, since at least three weeks green feed remained including large amounts of subterranean clover stimulated by the added phosphorus.

Results of the clippings made on the experimental plots set up in the control field of this demonstration showed a very great increase in forage from nitrogen plus phosphorus and that phosphorus was clearly necessary for maximum response. Analyses of the forage harvested showed, however, that only 29 percent of the applied nitrogen was recovered in the harvested forage. At other locations where less rainfall occurred the recovery of fertilizer nitrogen in the forage was 40 to 50 percent of that applied.

REDWOOD TEST - Sonoma County

January 20 - May 23, 1956 - 122 Days

I. TREATMENTS		
Nutrients/Acre	None	$N_{59}P_{33}$
Materials/Acre	--	219 Am. Sulfate 62 DiAm.Phosphate
Fertilizer Cost/Acre		
Materials		$10.80
Application		2.38
Field Size	122 Acres	90 Acres
II. STOCKING AND GRAZING		
Acres/Animal		
Jan. 20 - April 2	6.1 Acres	2.0 Acres
April 2 - May 23	6.1 Acres	4.1 Acres
Grazing Days/Acre	20.0	48.2
III. WEIGHT GAINS		
Av. Daily Gain	1.60 lbs.	1.63 lbs.
Beef Produced/Acre	32.1 lbs.	78.5 lbs.
Increase from Fertilizer		46.4 lbs.
IV. EVALUATION		
Total Grazing Income/Acre		
Beef @ 17¢/lb.	$ 5.46	$13.34
Less Fertilizer Cost/Acre		13.38
Net Grazing Income/Acre	5.46	.16
Net Loss/Acre from Fertilization		$5.30
V. FERTILIZER COST/LB		
of Extra Beef/Acre		28.0¢/lb.

KARN TEST - Yolo County

Carl Schoner - Farm Advisor

This test was set up in the fall of 1955 on open rolling rangeland near Brooks, some nine miles northwest of Esparto on the edge of the Capay Valley. The native vegetation here was composed largely of wild oats, soft chess and burr clover. Soil analyses indicated a relatively low phosphorus supply. Two experimental fields were fertilized by plane in October; one with straight nitrogen from ammonium sulfate and the other with approximately the same amount of nitrogen but with 41 pounds of P_2O_5 per acre. This was derived from diammonium phosphate which was mixed with ammonium sulfate in the plane hopper to give the desired rate of application.

The fall rains started growth early at this location and fields were about to be stocked when the torrential rains of late December and early January caused a postponement of stocking. By January 17 fields had dried out sufficiently to turn in the Hereford steers used in this test. The control field was stocked at a rate of four acres per animal, while 1.8 acres per animal was used on each of the fertilized fields. Carrying capacity as measured by grazing days per acre was approximately doubled by fertilization, with no difference between the straight nitrogen and nitrogen plus phosphorus treatments.

Two sets of animals were used in this test. The original group remained in the fields from January 17 to March 28, and were removed for sale at that time. The gains in weight of animals on the fertilized fields were somewhat greater than those on the control area. A second group of animals was purchased and placed in the field on April 3 and remained there until the termination of the test on May 24.

The production of beef was more than doubled by the application of nitrogen fertilizers in this test. The addition of phosphorus to nitrogen was not necessary. Clippings made in a small fenced demonstration plot showed no benefit of adding phosphorus at this location.

The results of this test have been evaluated using a figure of 18¢ per pound as a measure of the value of the steers at this location. On this basis, the straight nitrogen field produced almost exactly enough meat to pay for the cost of the fertilizer. The field where added phosphorus was applied showed a loss because of the extra unneeded expense of phosphate at this location. The fertilizer cost of the extra beef produced on the straight nitrogen treatment was 17.8¢ per pound.

Weather records at this location show that over 26 inches of rain fell in contrast to a normal rainfall of about 16 inches. Clearly substantial losses of nitrogen took place because of the excessive rains and water-logged conditions which prevailed. In spite of this a substantial increase in feed production was achieved and badly needed feed was produced at a time when little native feed was available.

KARN TEST - Yolo County

January 17 - May 24, 1956 - 128 Days

I.	TREATMENTS	Check	N	N + P
	Nutrients/Acre N	--	82.1	76.4
	P_2O_5	--	--	40.6
	Materials/Acre			
	Ammonium Sulfate	--	391	288
	Diammonium Phosphate	--	--	76.7
	Field Size	29 Acres	34 Acres	48 Acres
II.	STOCKING AND GRAZING			
	Acres/Animal	3.9	1.8	1.88
	Grazing days/Acre	36.7	70.8	68.0
III.	WEIGHT GAINS			
	Av. Daily Gains			
	Jan. 17 - March 28	.76 lbs.	1.85 lbs.	1.23 lbs.
	April 3 - May 24	2.0	1.36	2.05
	Entire Period	1.23	1.66	1.42
	Total Meat/Acre	40.1	117.1	96.8
	Increase over control		77.0	56.7
IV.	EVALUATION			
	Grazing income/Acre @ 18¢ beef	$7.22	$21.08	$17.42
	Less Fertilizer Cost			
	Material		10.96	13.91
	Application		2.75	2.75
			13.71	16.77
	Net Grazing Income	7.22	7.37	.76
	Profit or loss from fertilization	--	$ 0.15	-$ 6.46
V.	FERTILIZER COST OF EXTRA BEEF/ACRE		17.8¢/lb.	29.4¢/lb.

range fertilization can pay

this report shows that fertilization of

ANNUAL NATIVE RANGE
with
NITROGEN
plus Phosphorus and Sulfur if needed

- made earlier winter growth
- had less frost damage
- increased spring growth

Fertilized Grass
showed

- higher Crude Protein in winter period
- increased Phosphorus Content from NP materials on soils deficient in Phosphorus

IMPROVED CLOVER RANGE
with
PHOSPHORUS
on soils deficient in Phosphorus

- made little winter growth
- produced much more spring growth

Fertilized Clover-Grass Forage
showed

- much higher Crude Protein since more clovers were produced
- increased Phosphorus content of Forage
- high quality dry feed for summer and fall use

animals grazing on

SHOWED	ANNUAL NATIVE RANGE			IMPROVED CLOVER RANGE	
	CONTROL	FERTILIZED		FERTILIZED	CONTROL
	37	90	MORE GRAZING DAYS PER ACRE	91	66
	65	162	MORE POUNDS OF BEEF PER ACRE	173	100
	$11.65	$29.18	GREATER INCOME PER ACRE with 18¢ beef	$28.51	$16.55
BUT IT COST					
		$13.44	for fertilizer	$ 4.77	
		$ 1.49	to apply	$ .50	
LEAVING					
		$ 2.60	A NET PROFIT PER ACRE OF	$ 6.69	
		15.3¢/lb.	FERTILIZER COST OF EXTRA MEAT PRODUCED PER ACRE	6.5¢/lb.	

The figures above are average values from the cattle tests in this report.

Co-operative Extension work in Agriculture and Home Economics, College of Agriculture, University of California, and United States Department of Agriculture co-operating. Distributed in furtherance of the Acts of Congress of May 8, and June 30, 1914. George B. Alcorn, Director, California Agricultural Extension Service.

3/57---2000